CALTRANS HYDRAULICALLY DESIGNED (CHD) BIOFILTER STRIP EVALUATION PROGRAM

WATER QUALITY MONITORING SAMPLING AND ANALYSIS PLAN

DOCUMENT NO. CTSW-RT-02-054

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California Department of Transportation
1120 N Street
Sacramento, California 95814

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 PROJECT DESCRIPTION, ORGANIZATION, AND RESPONSIBILITY

1.1 Project Description

The Caltrans Hydraulically Designed (CHD) Biofilter Evaluation Program is a water quality monitoring study being undertaken to evaluate the removal of storm water contaminants by existing vegetated slopes adjacent to freeways. The objective of this program is to develop the information needed to determine if standard roadway design requirements result in functionally equivalent biostrips and bioswales. Variables such as width, slope, vegetation density, and hydraulic loading will be evaluated by studying the runoff through natural vegetated slopes at four locations in northern California and four locations in southern California. At each location, several 100-ft concrete channels will be constructed to capture freeway runoff after it passes through existing biostrips of varying widths. The width of the biostrip is defined as the distance from the edge of pavement to the collection channel. The quantity and quality of the runoff in the biostrip will be compared to freeway runoff collected at the edge of pavement.

1.2 General Scope of Monitoring Activities

The CHD Biofilter Evaluation Program is a two-year study. Caltrans monitored both northern and southern California sites during the 2001/02 wet season. Monitoring activities planned for the 2002/03 wet season (second year of the two-year study) include only southern California sites because of project funding limitations. Southern California sites were selected for monitoring over northern California sites because of the limited data set collected from the southern California sites during the 2001/02 wet season. If funding becomes available for the northern California sites, then those sites will also be monitored during the 2002/03 wet season. This Sampling and Analysis Plan represents information, procedures, and protocols for both northern and southern California sites. The monitoring effort will employ automated samplers and flow meters to collect flow-weighted composite samples throughout entire storm events from each of the monitoring locations for laboratory analyses. Up to eight storm events will be sampled at each monitoring location.

1.3 Project Organization and Responsibilities

The Project Organization is summarized in Figure 1-1. The Caltrans Project Coordinator for this project will be Misty Scharff, and the Caltrans Contract Manager will be Mark Rayback. URS is the primary consultant for monitoring this project. The overall project manager is Carol Forrest, URS, and the Task Order Manager is Ed Othmer, URS. Nathan Jacobsen, URS, is the Assistant Task Order Manager; he will coordinate the field sampling effort. Nathan Jacobsen, will also serve as the Project Safety Officer. Laboratory analyses will be conducted under the supervision of Pat Brueckner of Pat-Chem Laboratories. Rich Amano, Laboratory Data Consultants, Inc., will be responsible for laboratory data validation. Kim Williams of URS will be responsible for project Quality Assurance/Quality Control (QA/QC) and for assuring that the laboratory QA/QC requirements are met. Tully McCarthy of URS will be responsible for hydrologic and hydraulic data management; Ed Othmer, URS, will be responsible for data analysis/reporting. Salix Applied Earthcare will be providing field teams for two of the northern California sites, MARRS Services, Inc. will be providing one field team for one southern California site, and URS will provide field teams for the remaining five sites.

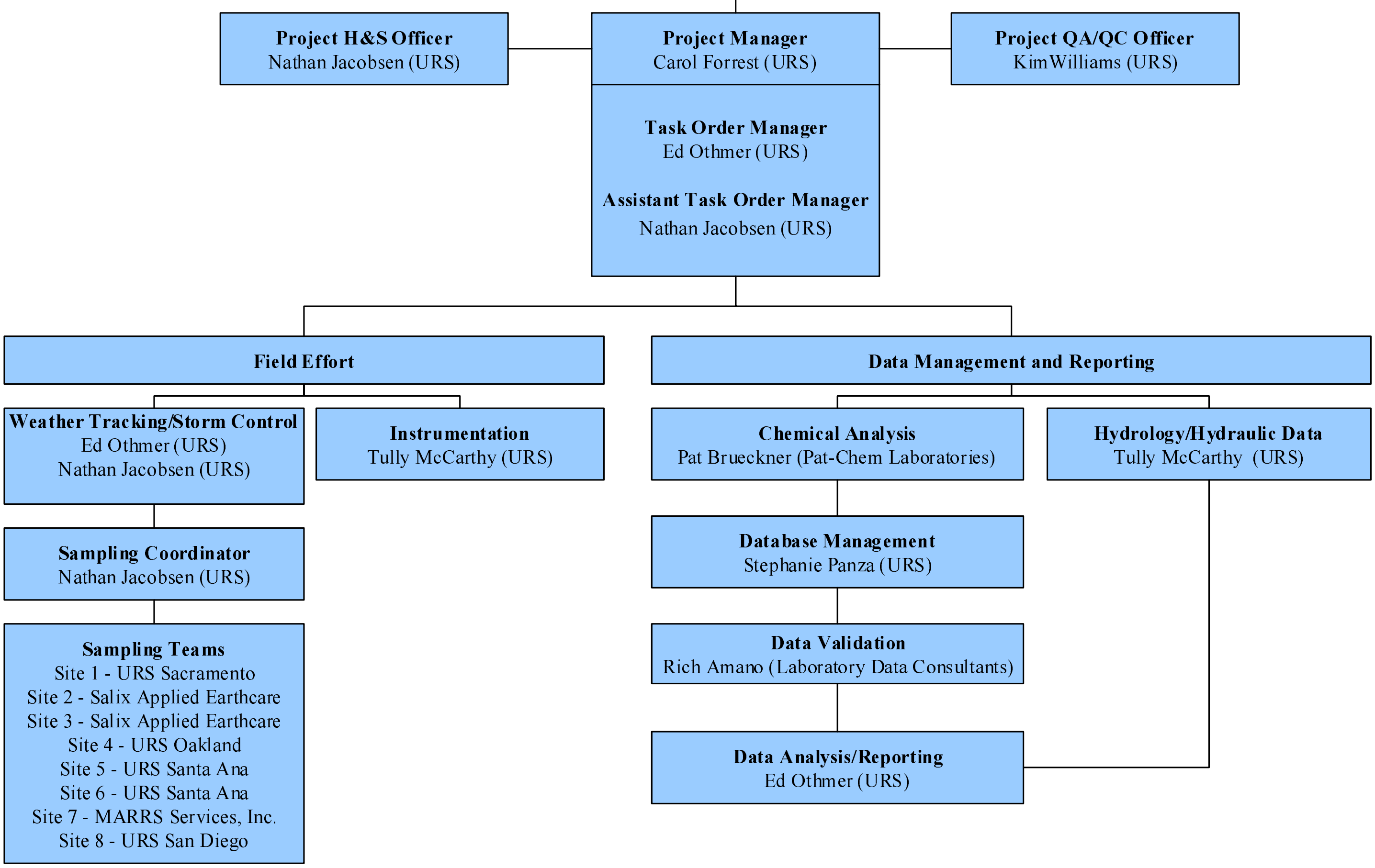


Figure 1-1. Project Organization

Section 2

2 DESCRIPTION OF SAMPLING SITES

Selecting sites for the Caltrans Hydraulically Designed (CHD) Biofilter Strip Evaluation Program involved an initial inspection of the areas owned by Caltrans along freeways and highways. A range of test conditions provided by Caltrans for sighting guidance include:

- Minimum roadway/vegetated shoulder-slope length of 152 m;
- Minimum vegetated shoulder-slope width of 8 m; and
- Slopes across the biofilter strip ranging from less than 5 percent to greater than 30 percent.

The width of the biofilter strip, defined as the direction of the flow across the vegetated area, must include adequate space for the test area and monitoring equipment and an access road to the monitoring equipment. The initial inspection also took into consideration safe access to the area for the field teams. The locations of the monitoring sites are described in Table 2-1 and shown in Figures 2-1a through 2-1i. Driving directions from the Caltrans District offices to the various monitoring sites are given in Table 2-2.

Table 2-1. Location of Eight Sites Picked for CHD Biofilter Strip Evaluation Program

Site No.	Caltrans Statewide Site ID	Location	Freeway	Post Mile	County	Caltrans District	Regional Board	Avg Annual Rainfall (in)	Avg Annual Daily Trips (AADT)
1	3-213 3-214 3-215 3-216 3-217	City: Sacramento *Northbound between Pocket and Laguna Exits*	I-5	13.5	Sacramento	3	5b	17.2	75,000
2	2-201 2-202	City: Cottonwood *Southbound near Cottonwood Exit*	I-5	1.5	Shasta	2	5a	39.4	38,500
3	2-203 2-204 2-205 2-206	City: Redding *Eastbound near Old Oregon Trail/Shasta College Exist*	SR-299	26.0	Shasta	2	5a	39.4	11,800
4	4-213 4-214	City: San Rafael *Northbound at St. Vincent on-ramp*	US-101	15.0	Marin	4	2	35.9	151,000
5	12-225 12-226 12-227 12-228 12-229	City: Yorba Linda *Eastbound between Weir Canyon Road and SR-241 Exits*	SR-91	15.0	Orange	12	8	14.1	226,000
6	12-230 12-231 12-232 12-233	City: Irvine *Northbound at Sand Canyon Ave off-ramp*	I-405	2.5	Orange	12	8	12.8	237,000
7	8-201 8-202 8-203 8-204 8-205	City: Moreno Valley *Eastbound at Fredrick St. on-ramp*	SR-60	14.0	Riverside	8	8	10.3	106,000
8	11-204 11-205 11-206 11-207	City: San Onofre *Northbound near Basilone Exit*	I-5	70.4	San Diego	11	9	10.3	124,000

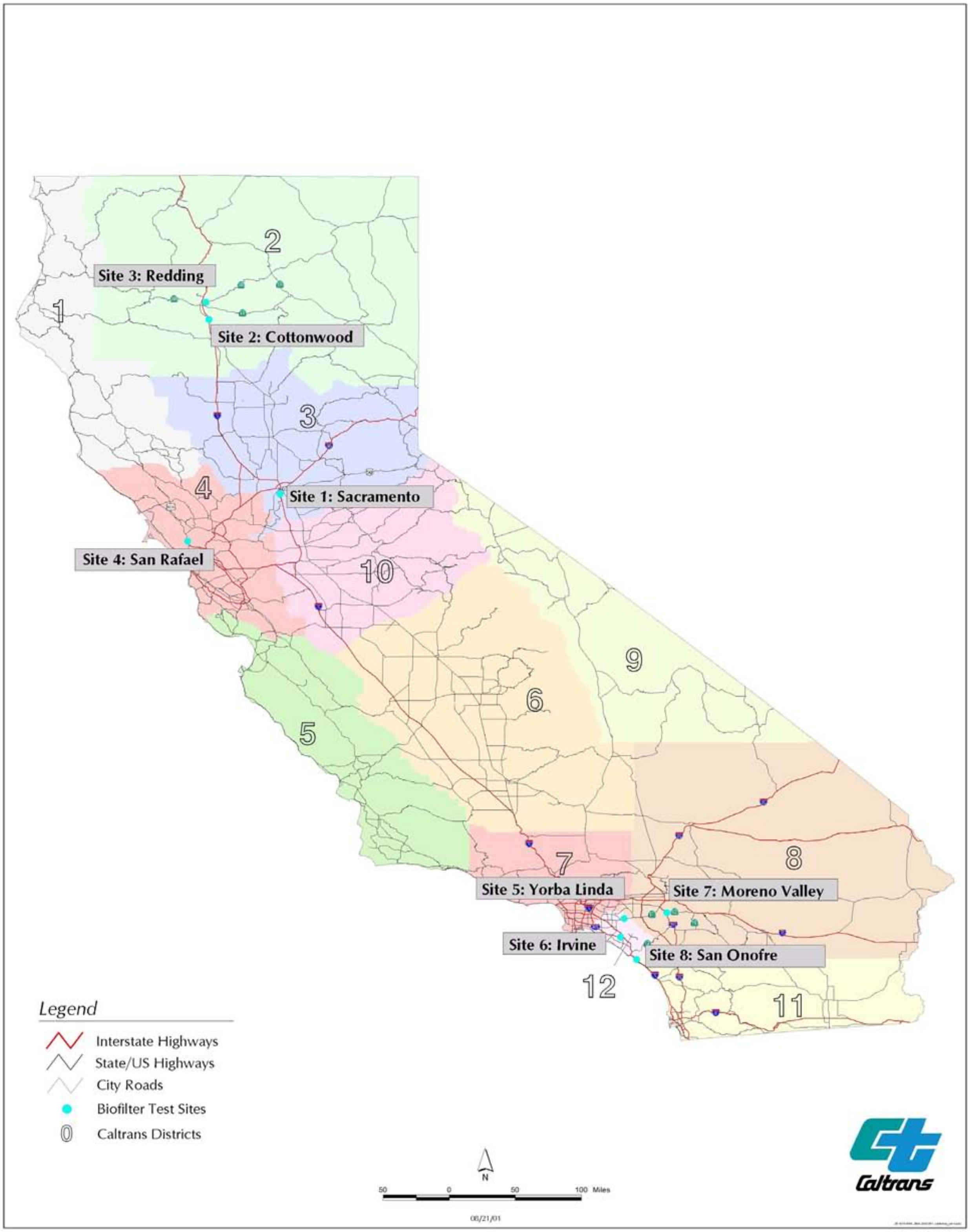


Figure 2-1a. CHD Biofilter Site Map

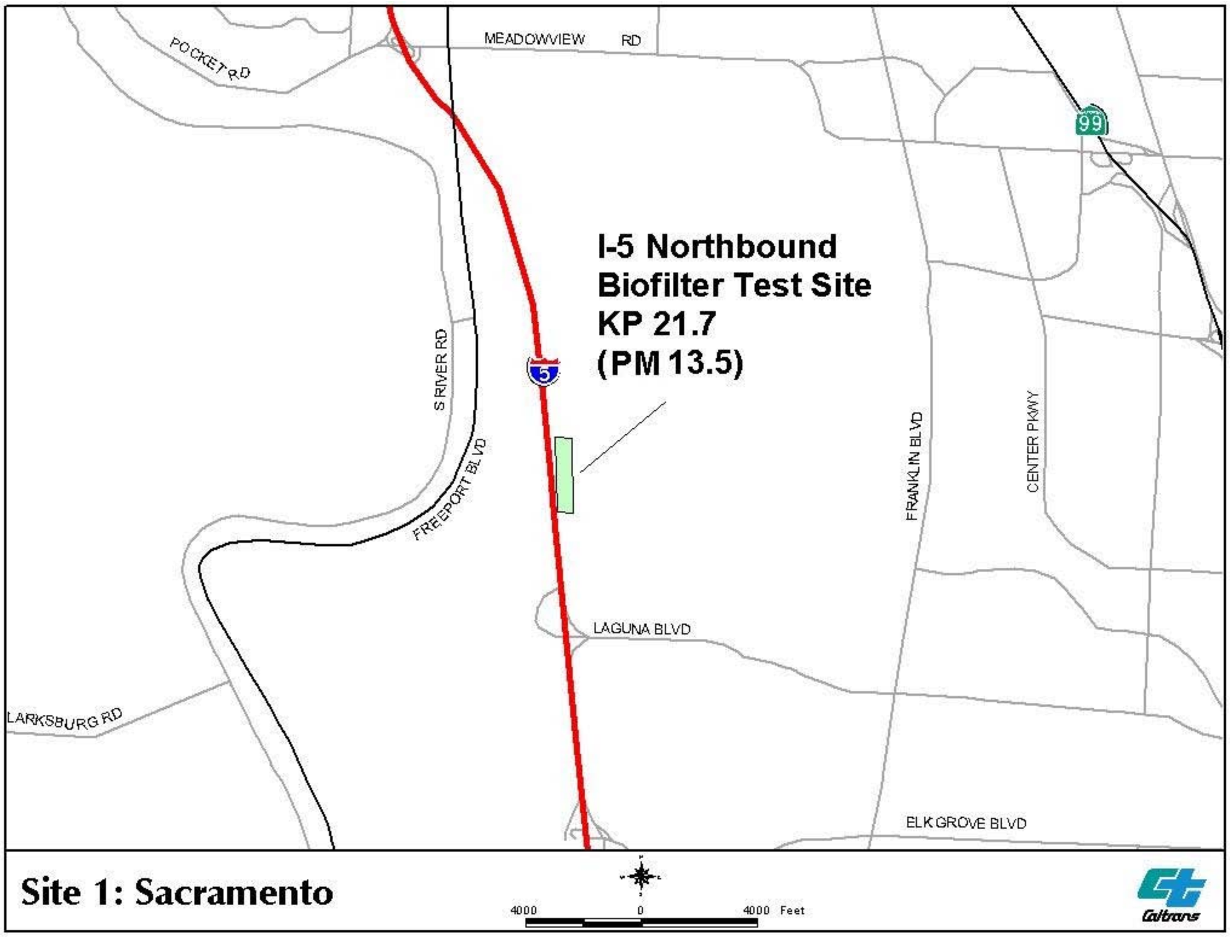


Figure 2-1b. Location of Site #1 (Sacramento)

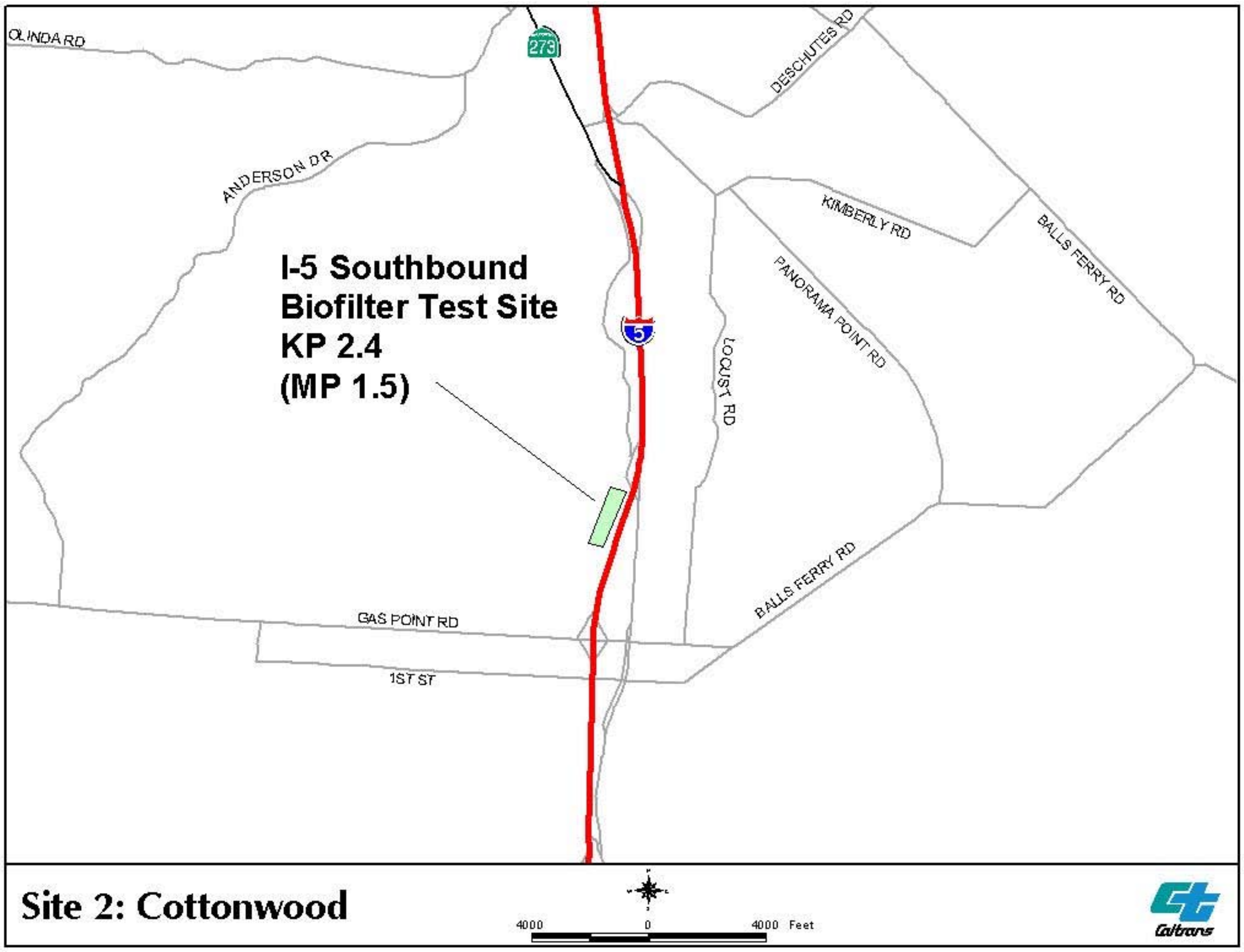


Figure 2-1c. Location of Site #2 (Cottonwood)

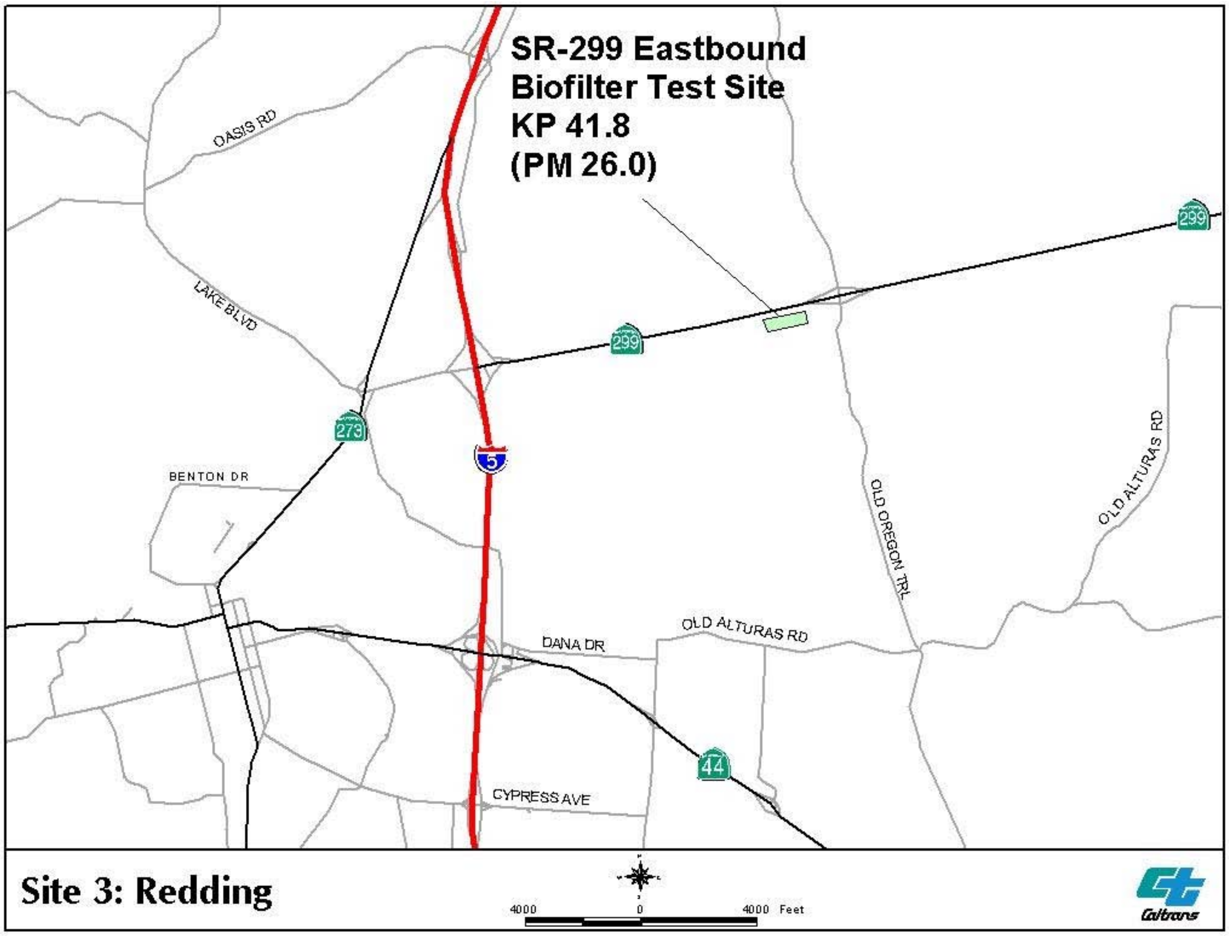


Figure 2-1d. Location of Site #3 (Redding)

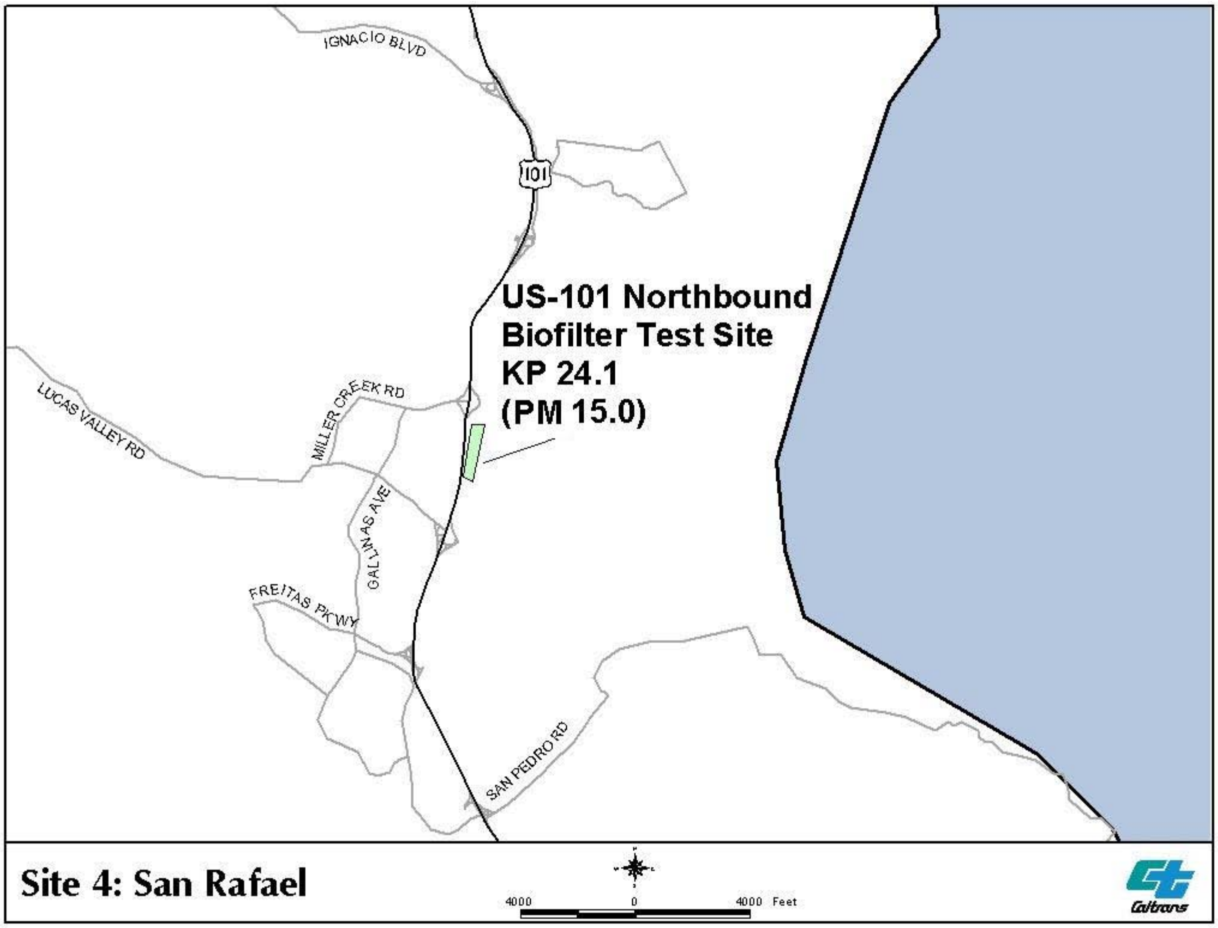


Figure 2-1e. Location of Site #4 (San Rafael)

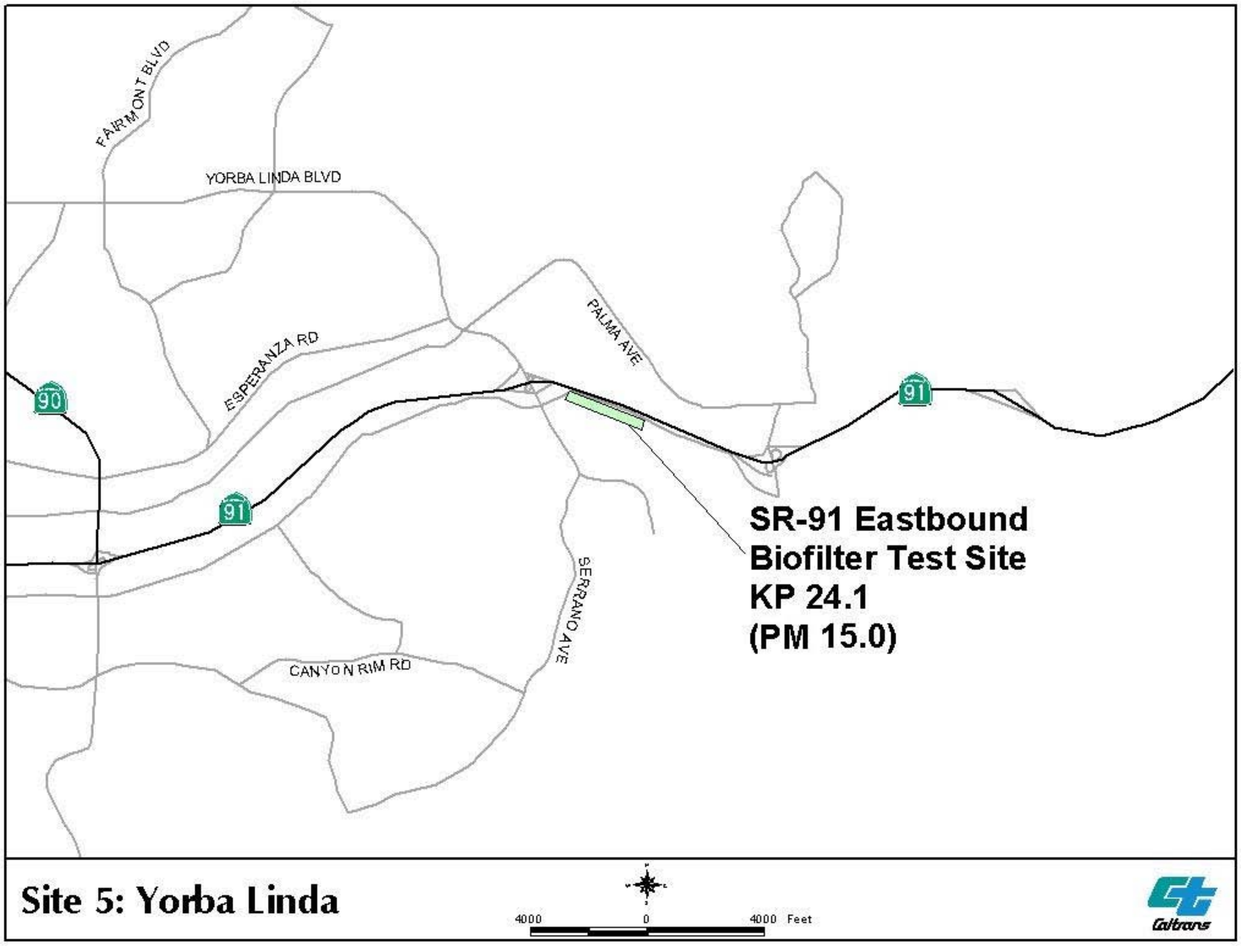


Figure 2-1f. Location of Site #5 (Yorba Linda)

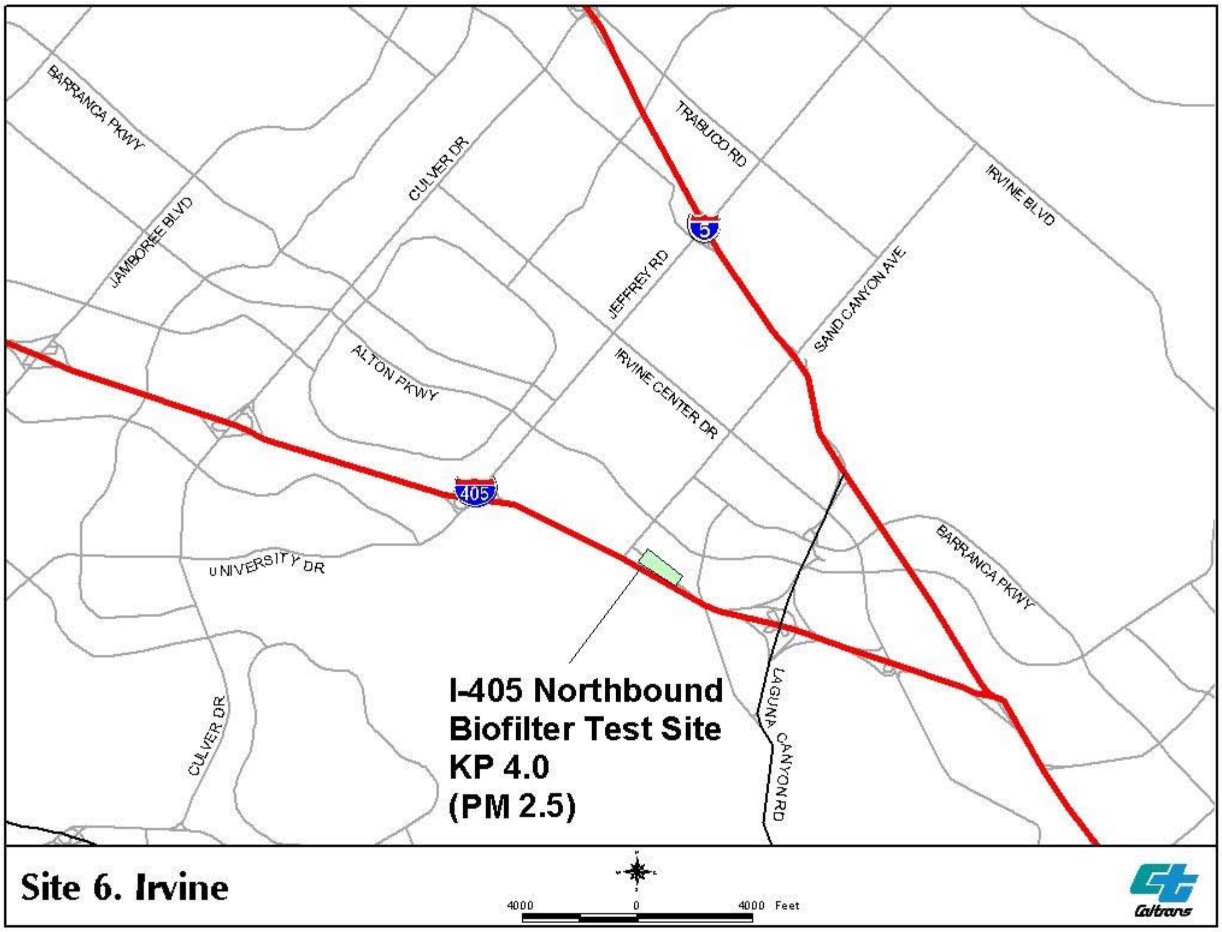


Figure 2-1g Location of Site #6 (Irvine)

Figure 2-1h. Location of Site #7 (Moreno Valley)

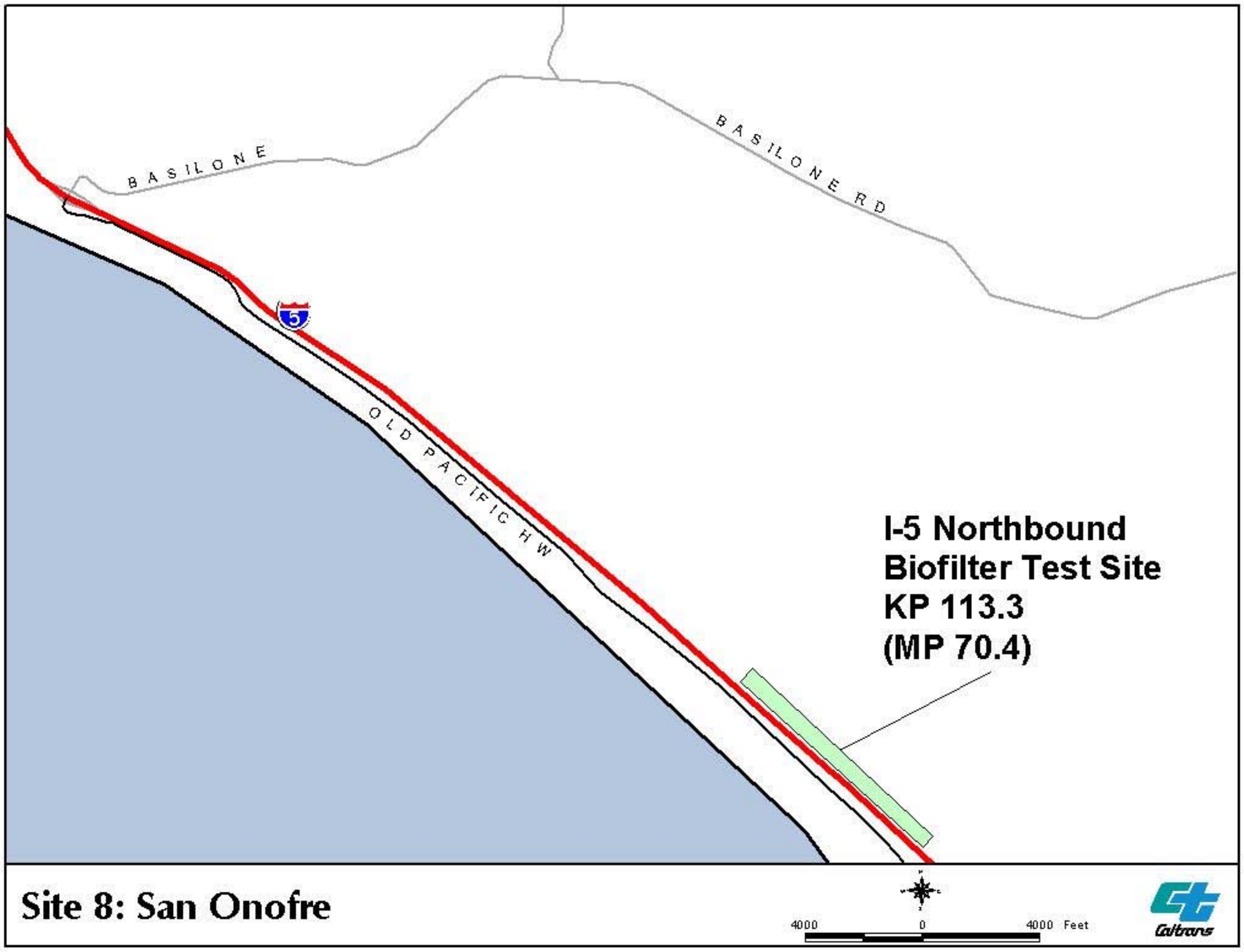


Figure 2-1i. Location of Site #8 (San Onofre)

Table 2-2. Driving Directions to Biofilter Sites

Site No.	Site Location	Proceeding from:	Directions
1	Sacramento site	District 3 office	Proceed west on the I-20/I-70 Left on the I-70 south To the I-5/SR-299 Southbound To the I-5 Southbound Exit at Laguna, turn left Proceed to the first light and make a u-turn to the I-5 Northbound Site is 2 miles north of Laguna
2	Cottonwood site	District 2 office	Right onto Riverside Dr. Right onto California St. Left on Shasta St. To the I-5 Southbound Take the Cottonwood exit Site is on the right before going under the I-5
3	Redding site	District 2 office	Right onto Riverside Dr. Right onto California St. Left on Shasta St. To the I-5 Northbound To the SR-299 Eastbound Site is 1 mile east of the Churn Creek Road exit
4	San Rafael site	District 4 office	Start out going West on W. Grand Ave. Turn Right onto Northgate Ave. Take the I-580 ramp towards San Francisco Merge onto US-101 N Site is at PM 15.0 just before St. Vincent Dr. exit
5	Yorba Linda site	District 12 office	Start out going Southeast on Michelson Dr. by turning left Turn left onto Culver Dr. Take the I-405 Northbound Take the SR-55 Northbound Take the SR-91 Eastbound The site is just past the Weir Canyon exit
6	Irvine site	District 12 office	Start out going southeast on Michelson Dr. by turning left. Turn Left onto Culver Dr. Take the I-405 Southbound ramp Take the Irvine Center Drive exit Take the I-405 Northbound The site is at the Sand Canyon exit
7	Moreno Valley site	District 8 office	Turn right on W 4th St. Turn left on N E St. Turn right on W. 2nd St. To the I-215 Southbound To SR-60 Eastbound Site just past the Day St. exit
8	San Onofre site	District 11 office	Start out going west on Taylor St. by turning right Turn right onto Pacific Hwy. Turn right onto Sea World Dr. Merge onto I-5 N Site is on I-5 northbound at PM 70.4, 1.5 miles south of Basilone exit

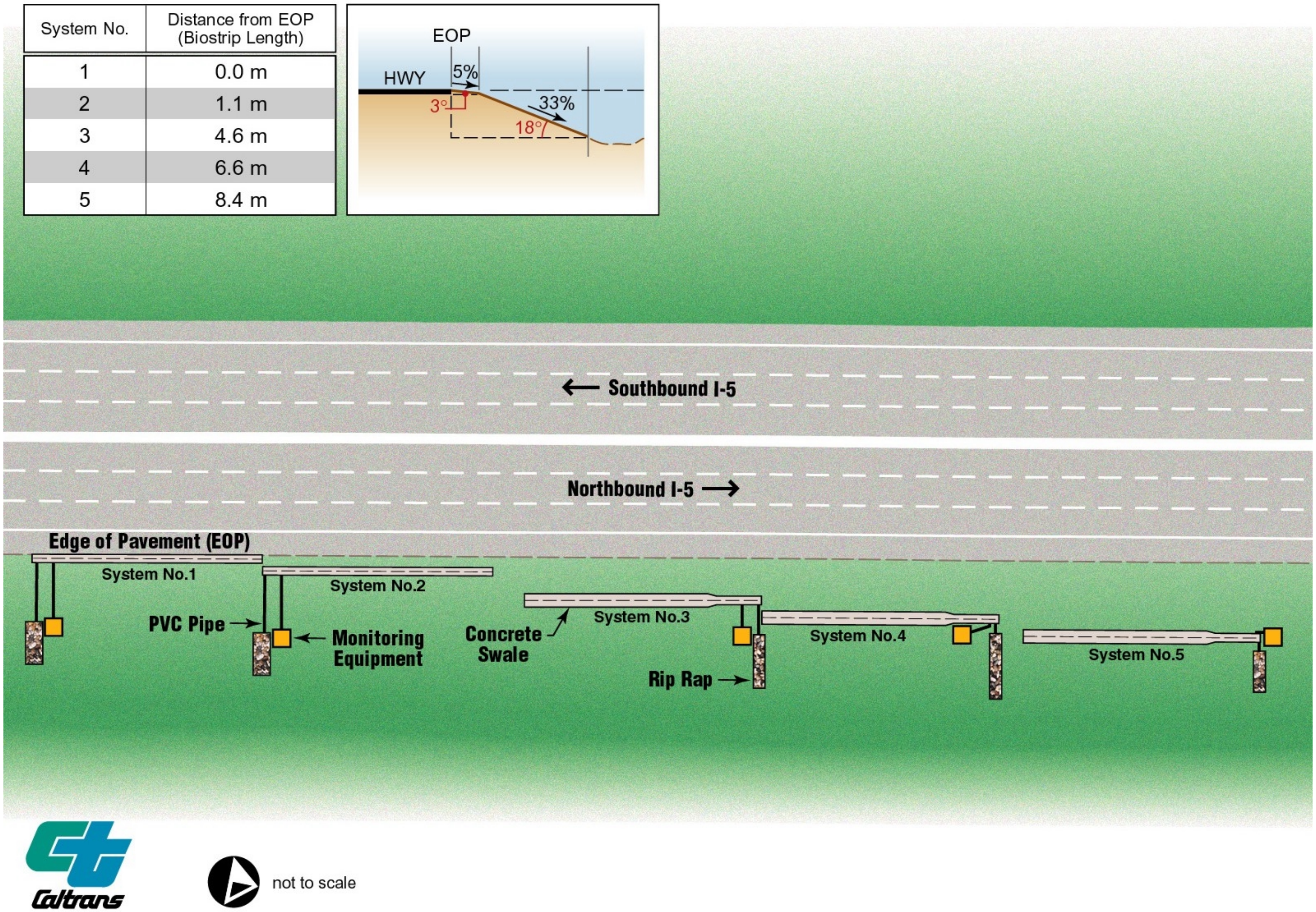
2.1 Site #1: Sacramento, I-5 (Northbound), District 3

The biofilter strip is located along I-5 northbound between Pocket and Laguna exits at PM 13.50 (Figure 2-2). The area can be accessed from the I-5 northbound shoulder or the access road located behind the fence (with permission). The site receives approximately 0.7 ac of runoff from the I-5 northbound three lanes and shoulder. The site has 2 to 3 m at a 2.2 percent slope from the edge of pavement before a 28 percent slope begins and continues to the right-of-way. The width from the edge of pavement to the right of way is 21 m. The strip is at least 153 m in length. Grass coverage is good.

Four biofilter strip collection systems and one baseline collection system were constructed at Site #1. Figure 2-2 shows a plan view of the collection systems. Each collection system consists of a 28-m long concrete V-ditch, constructed parallel to the northbound lanes of I-5. The V-ditches were positioned about 2, 5, 7, and 9 m from the edge of pavement and adjacent to the edge of pavement (baseline). A 2-in, 60-degree trapezoidal flume was installed at the downstream end of each collection ditch. Monitoring equipment was installed in five separate enclosures located on concrete pads positioned about 5 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-2. Plan View of Site #1 (Sacramento)

System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	1.1 m
3	4.6 m
4	6.6 m
5	8.4 m

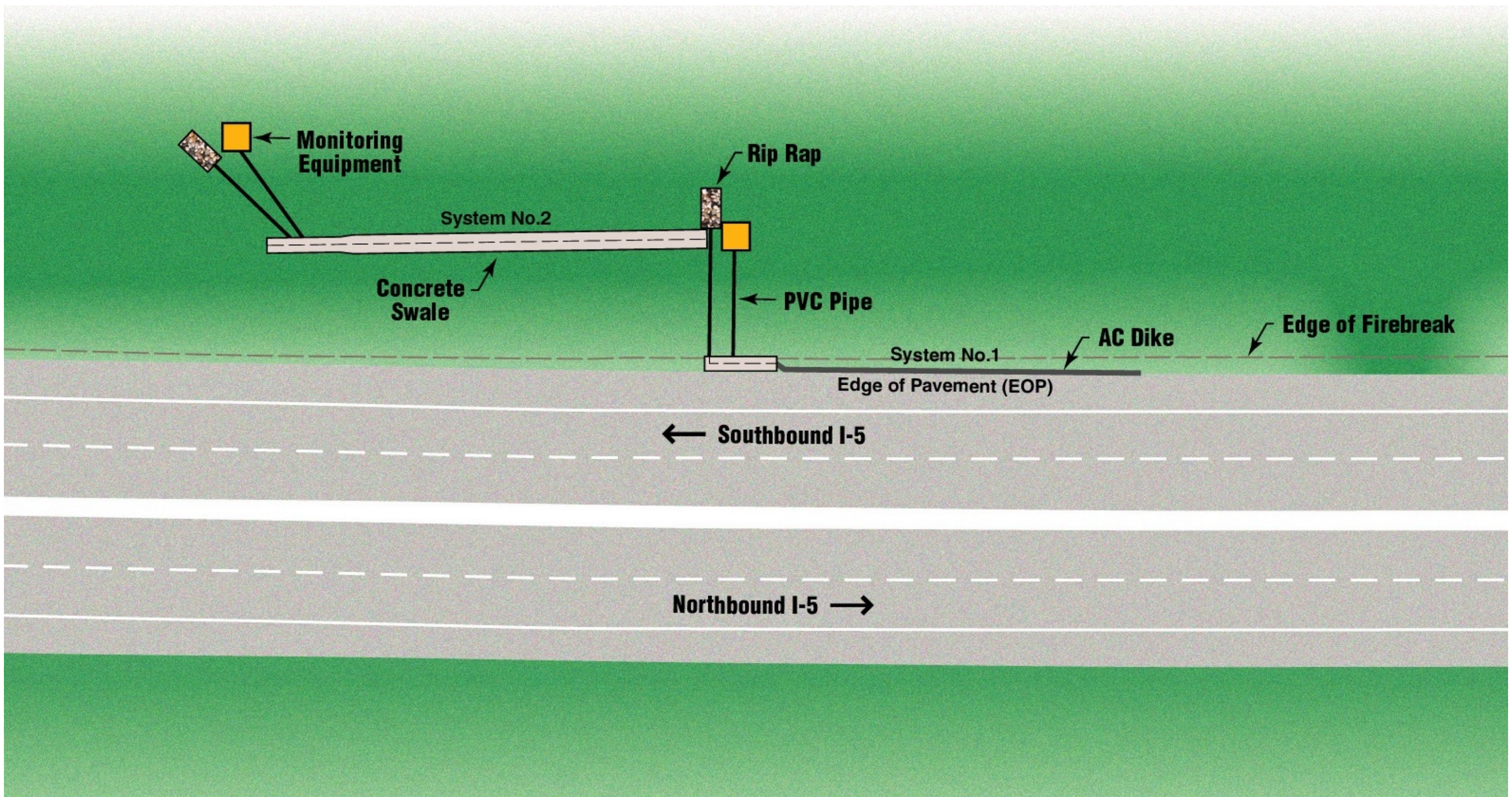


2.2 Site #2: Cottonwood, I-5 (Southbound), District 2

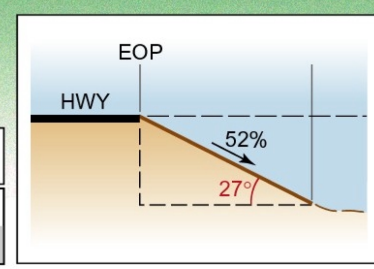
The biofilter strip is located along I-5 southbound at Cottonwood exit, south of the bridge (Figure 2-3). The area can be accessed from the Cottonwood exit offramp. This site receives approximately 0.5 ac of runoff from the two I-5 southbound lanes and shoulder. The site has a 50 percent slope. The width from the edge of pavement to the end of the right-of-way is at least 14 m. The strip is at least 153 m in length. Grass coverage is good.

One biofilter strip collection system and one baseline collection system were constructed at Site #2. Figure 2-3 shows a plan view of the collection systems. The biofilter strip collection system consists of a 26.5-m long concrete V-ditch, constructed parallel to the southbound lanes of I-5. The V-ditch was positioned about 9 m from the edge of pavement at the bottom of the steep embankment. The baseline collection system consists of a 27.5-m long concrete curb that directs the runoff to a short concrete channel. A-2 in, 60-degree trapezoidal flume was installed at the downstream end of both collection channels. Monitoring equipment was installed in two separate enclosures located on concrete pads positioned at the toe of the steep embankment. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. A lateral conveyance 50-mm in diameter will bring runoff from the baseline collection channel to the equipment enclosure.

Figure 2-3..Plan View of Site #2 (Cottonwood)



System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	9.3 m

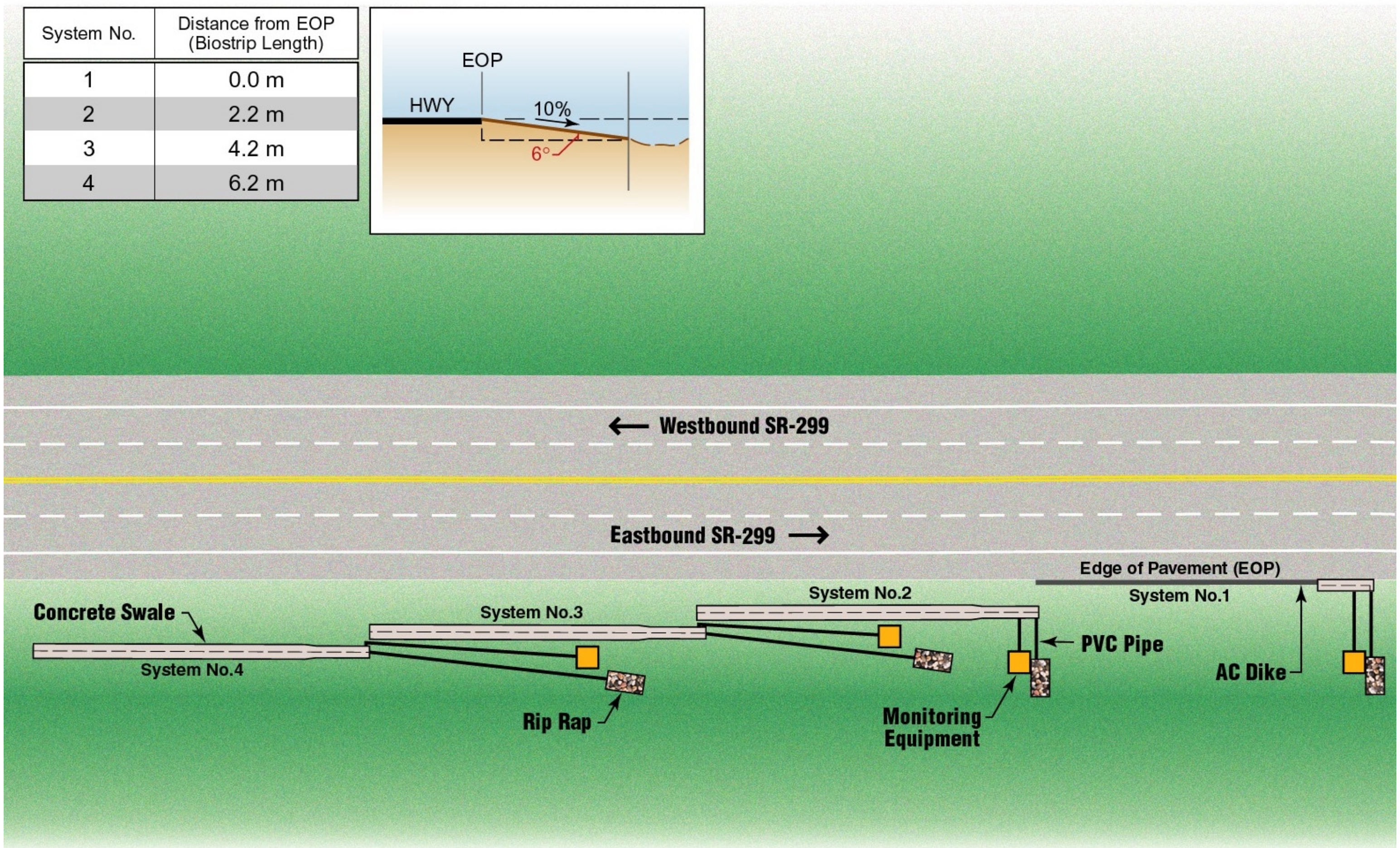


2.3 Site #3: Redding, SR-299 (Eastbound), District 2

The biofilter strip is located along SR-299 eastbound between Churn Creek Road and Old Oregon Trail/Shasta College exits at the PM 26.00 (Figure 2-4). The area can be accessed from the SR-299 eastbound shoulder or the access road located behind the fence. The site receives approximately 0.5 ac of runoff from the two SR-299 eastbound lanes and shoulder. The site has a 4 percent slope. The width from the edge of pavement to the end of the right-of-way is 9 m. The strip is at least 153 m in length. Grass coverage is good

Three biofilter strip collection systems and one baseline collection system were constructed at Site #3. Figure 2-4 shows a plan view of the collection systems. Each biofilter collection system consists of a 26.5-m long concrete V-ditch, constructed parallel to the eastbound lanes of SR-299. The V-ditches were positioned about 3, 5, and 7 m from the edge of pavement. The baseline collection system consists of a 27.5-m long concrete curb that directs the runoff to a short concrete collection channel. A 2-in, 60-degree trapezoidal flume was installed at the downstream end of each collection channel. Monitoring equipment was installed in four separate enclosures located on concrete pads positioned about 9 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-4. Plan View of Site #3 (Redding)



System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	2.2 m
3	4.2 m
4	6.2 m

not to scale

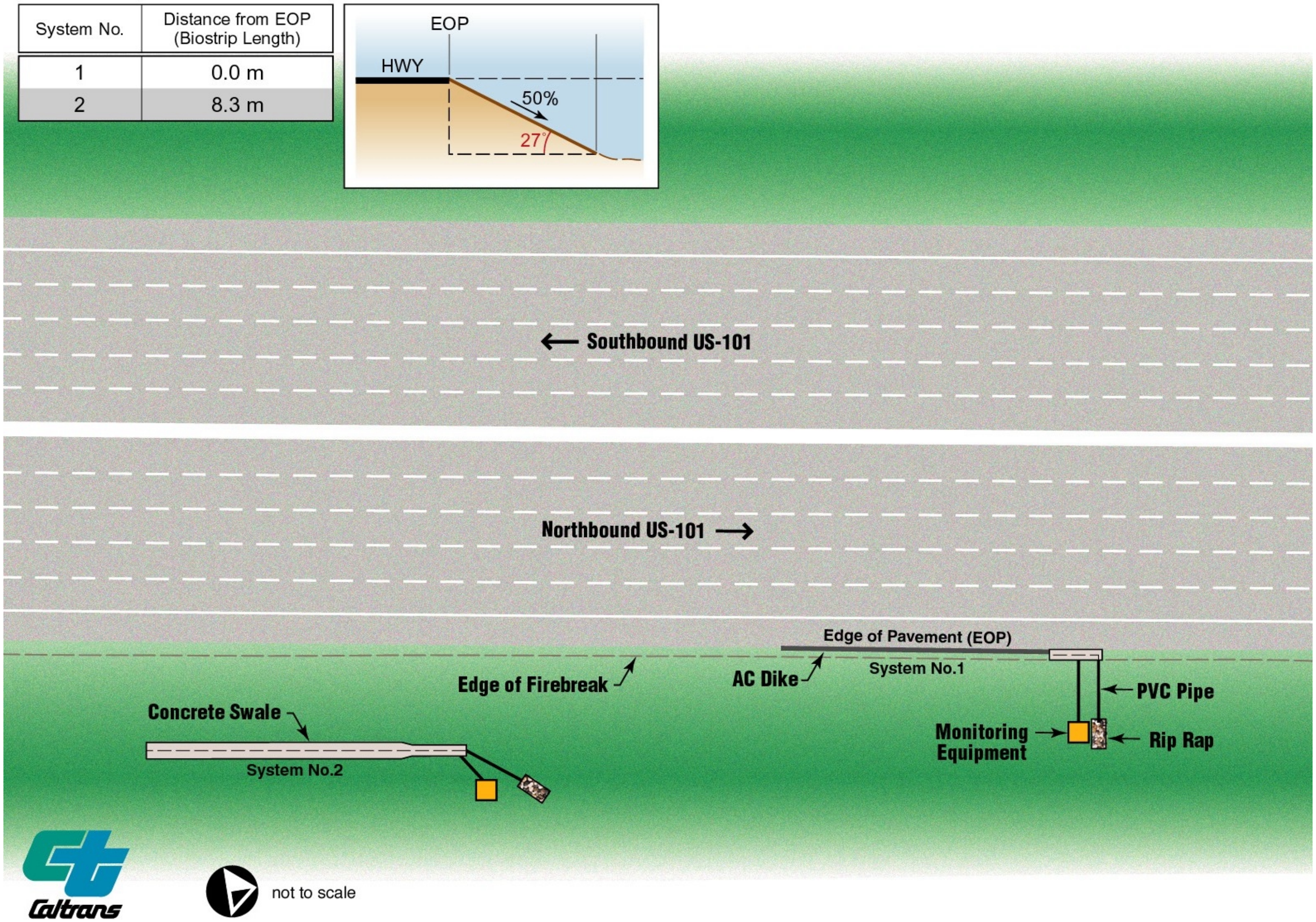
2.4 Site #4: San Rafael, US-101 (Northbound), District 4

The biofilter strip is located along the northbound US-101 between Smith Ranch Road and Saint Vincents Drive in San Rafael (Figure 2-5). The area can be accessed from the US-101 northbound shoulder. The site receives approximately 0.21 ac of runoff from the five northbound lanes and shoulder of US-101. The site has a 35 percent slope. The width from the edge of pavement to the end of right of way is at least 12 m. The strip is at least 60 m in length. Grass coverage is good.

One biofilter strip collection system and one baseline collection system were constructed at Site #4. Figure 2-5 shows a plan view of the collection systems. The biofilter strip collection system consists of a 28-m long concrete V-ditch, constructed parallel to the northbound lanes of US-101. The V-ditch was positioned about 6 m from the edge of pavement. The baseline collection system consists of a 27.5-m long concrete curb that directs the runoff to a short concrete channel. A 2-in, 60-degree trapezoidal flume was installed at the downstream end of both collection channels. Monitoring equipment was installed in two separate enclosures located on concrete pads positioned about 5 m from the edge of pavement. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. A lateral conveyance 50-mm in diameter was installed to bring runoff from the baseline collection channel to the equipment enclosure.

Figure 2-5. Plan View of site #5 (San Rafael)

System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	8.3 m



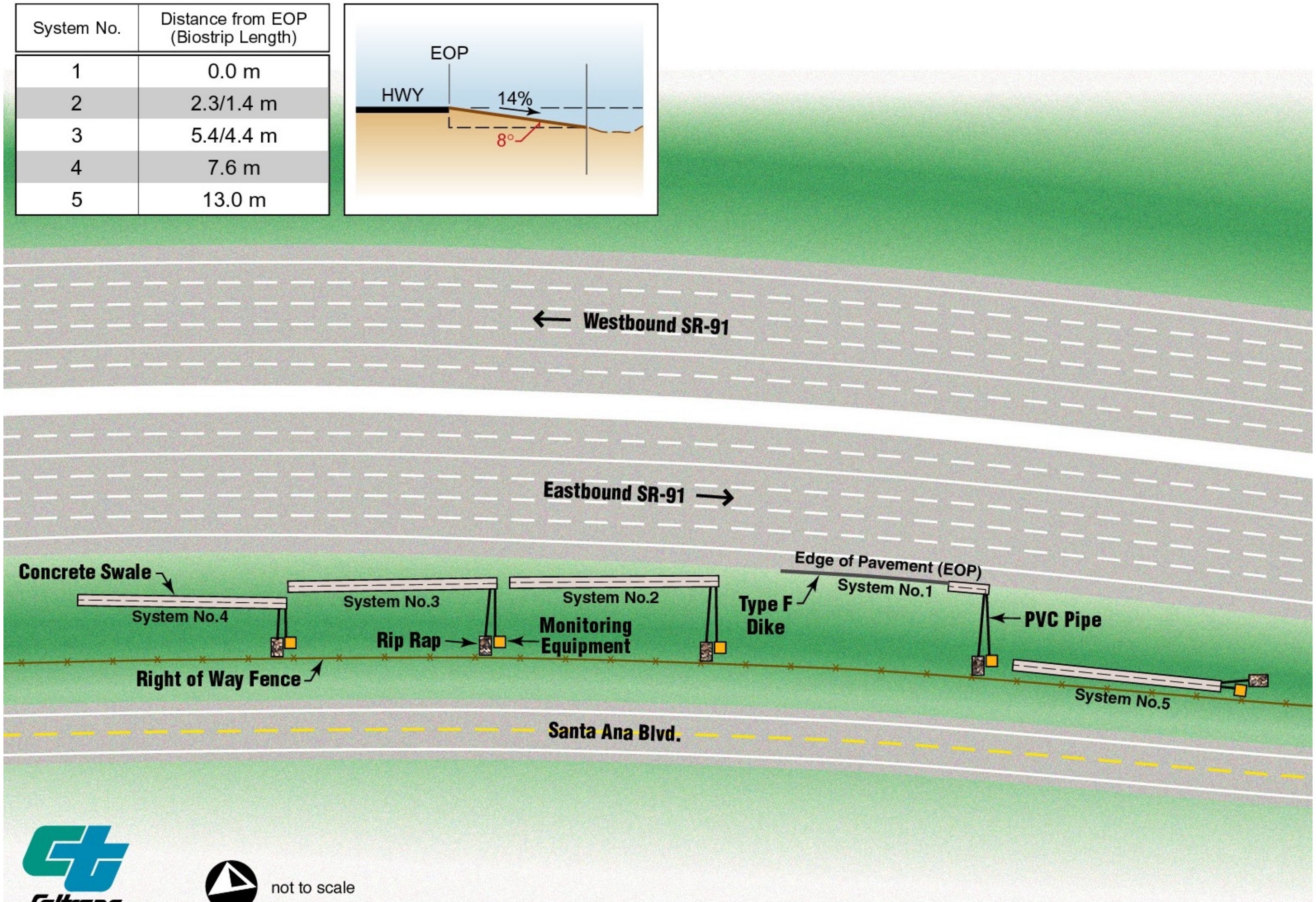
2.5 Site #5: Yorba Linda, SR-91 (Eastbound), District 12

The biofilter strip is located along the SR-91 eastbound between Weir Canyon and SR-241 exits (Figure 2-6). The area can be accessed from the SR-91 eastbound shoulder. The site receives approximately 1.2 ac of runoff from the six lanes of eastbound SR-91 plus the shoulder. The site has a slope of 10 percent. The width from the edge of pavement to the end of the right-of-way is at least 10 m. The strip is at least 153 m in length. The grass coverage is moderate.

Four biofilter strip collection systems and one baseline collection system were constructed at Site #5. Figure 2-6 shows a plan view of the collection systems. Each collection system consists of a 30-m long concrete V-ditch, constructed parallel to the eastbound lanes of SR-91. The V-ditches were positioned about 2, 5, 8, and 13 m from the edge of pavement. The baseline collection system consists of a 30-m long concrete curb that directs the runoff to a short concrete ditch. A 2-in, 60-degree trapezoidal flume was installed at the downstream end of each collection ditch. Monitoring equipment was installed in five separate enclosures located on concrete pads positioned about 10 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-6. Plan View of Site #6 (Yorba Linda)

System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	2.3/1.4 m
3	5.4/4.4 m
4	7.6 m
5	13.0 m

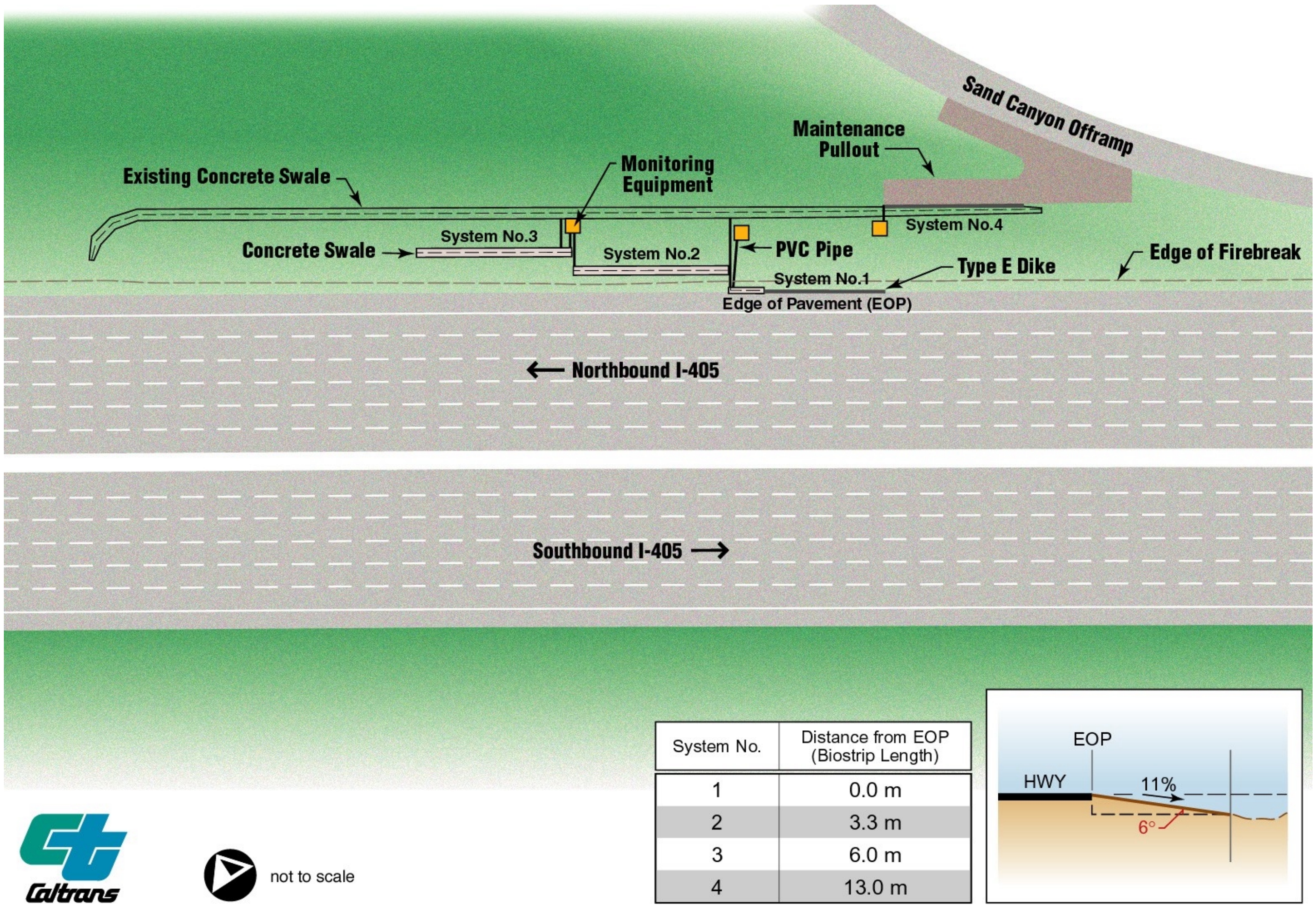


2.6 Site #6: Irvine, I-405 (Northbound), District 12

The biofilter strip is located along the I-405 northbound at the Sand Canyon exit. The area can be accessed from the Sand Canyon offramp (Figure 2-7). The site receives approximately 1.0 ac of runoff from the five northbound lanes of I-405 and the shoulder. The site has a slope of 10 percent. The width from the edge of pavement to the end of the right-of-way is greater than 15 m. The strip is at least 153 m in length. Grass coverage is good, and there is a 1-m firebreak.

Three biofilter strip collection systems and one baseline collection system were constructed at Site #6. Figure 2-7 shows a plan view of the collection systems. Each biofilter collection system consists of a 20-m long concrete V-ditch, constructed parallel to the northbound lanes of I-405. The V-ditches were positioned 3, 6, and 13 m from the edge of pavement. The baseline collection system consists of a 20-m long concrete curb that directs the runoff to a short concrete collection channel. A 2-in, 60-degree trapezoidal flume was installed at the downstream end of each collection channel. Monitoring equipment was installed in three separate enclosures located on concrete pads positioned about 10 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-7. Plan View of Site #6 (Irvine)



System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	3.3 m
3	6.0 m
4	13.0 m

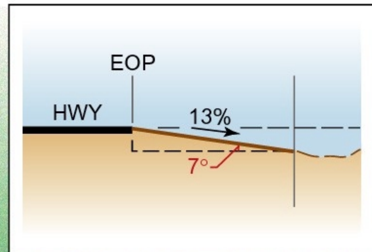
2.7 Site #7: Moreno Valley, SR-60 (Eastbound), District 8

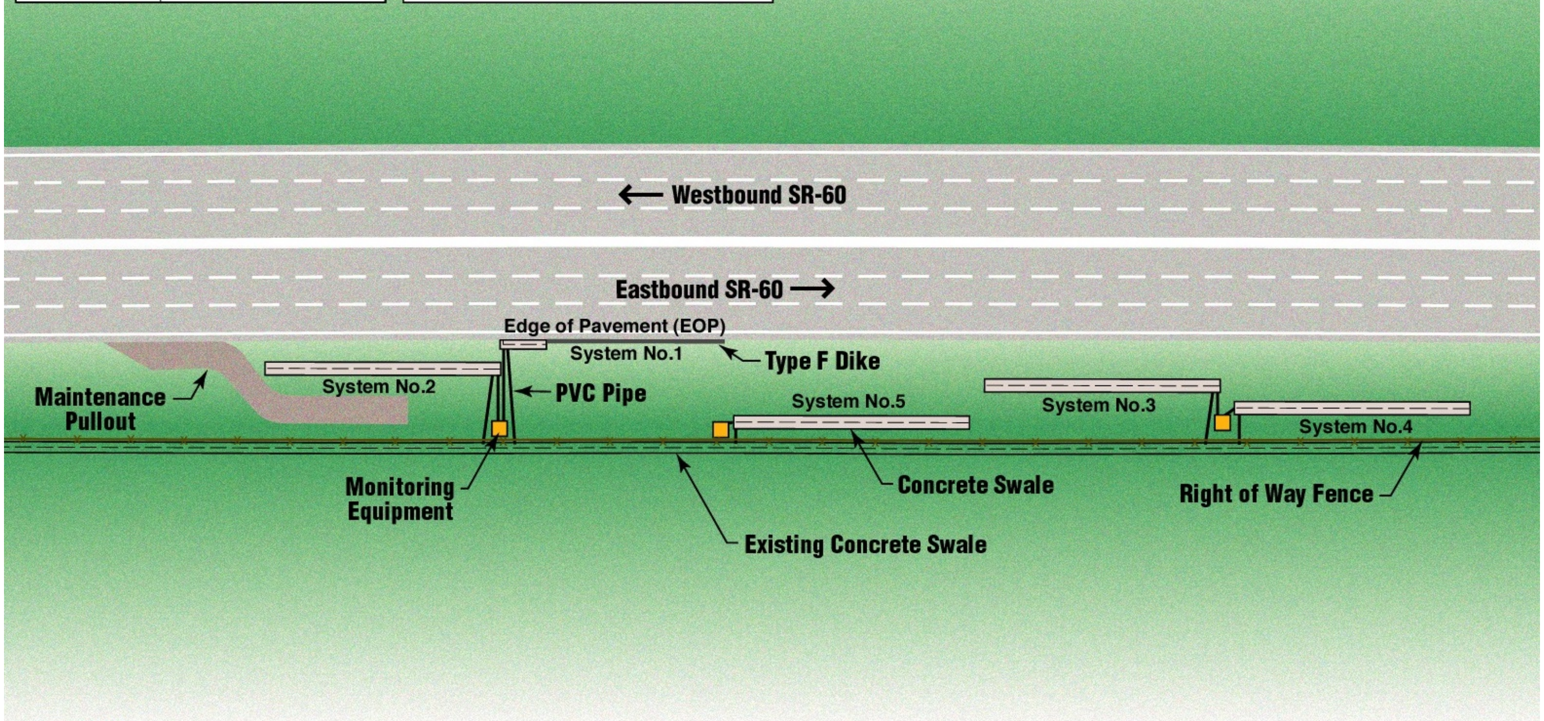
The biofilter strip is located along the SR-60 eastbound at Frederick Street (Figure 2-8). The area can be accessed from the SR-60 eastbound shoulder. The site receives approximately 0.7 ac of runoff from the three eastbound lanes of SR-60 and the eastbound shoulder. The site has a slope of less than 5 percent. The width from the edge of pavement to the end of right of way is greater than 11 m. The strip is at least 153 m in length. This site has sparse vegetation in high desert climate.

Four biofilter strip collection systems and one baseline collection system were constructed at Site #7. Figure 2-8 shows a plan view of the collection systems. Each collection system consists of a 25-m long concrete V-ditch, constructed parallel to the eastbound lanes of SR-60. The V-ditches were positioned about 2.5, 5, 8, and 10 m from the edge of pavement. The baseline collection system consists of a 25-m long concrete curb that directs the runoff to a short concrete collection channel. A 2-in, 60-degree trapezoidal flume was installed at the downstream end of each collection ditch. Monitoring equipment was installed in four separate enclosures located on concrete pads positioned about 10 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-8. Plan View of Site #7 (Moreno Valley)

System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	2.6 m
3	4.9 m
4	8.0 m
5	9.9 m





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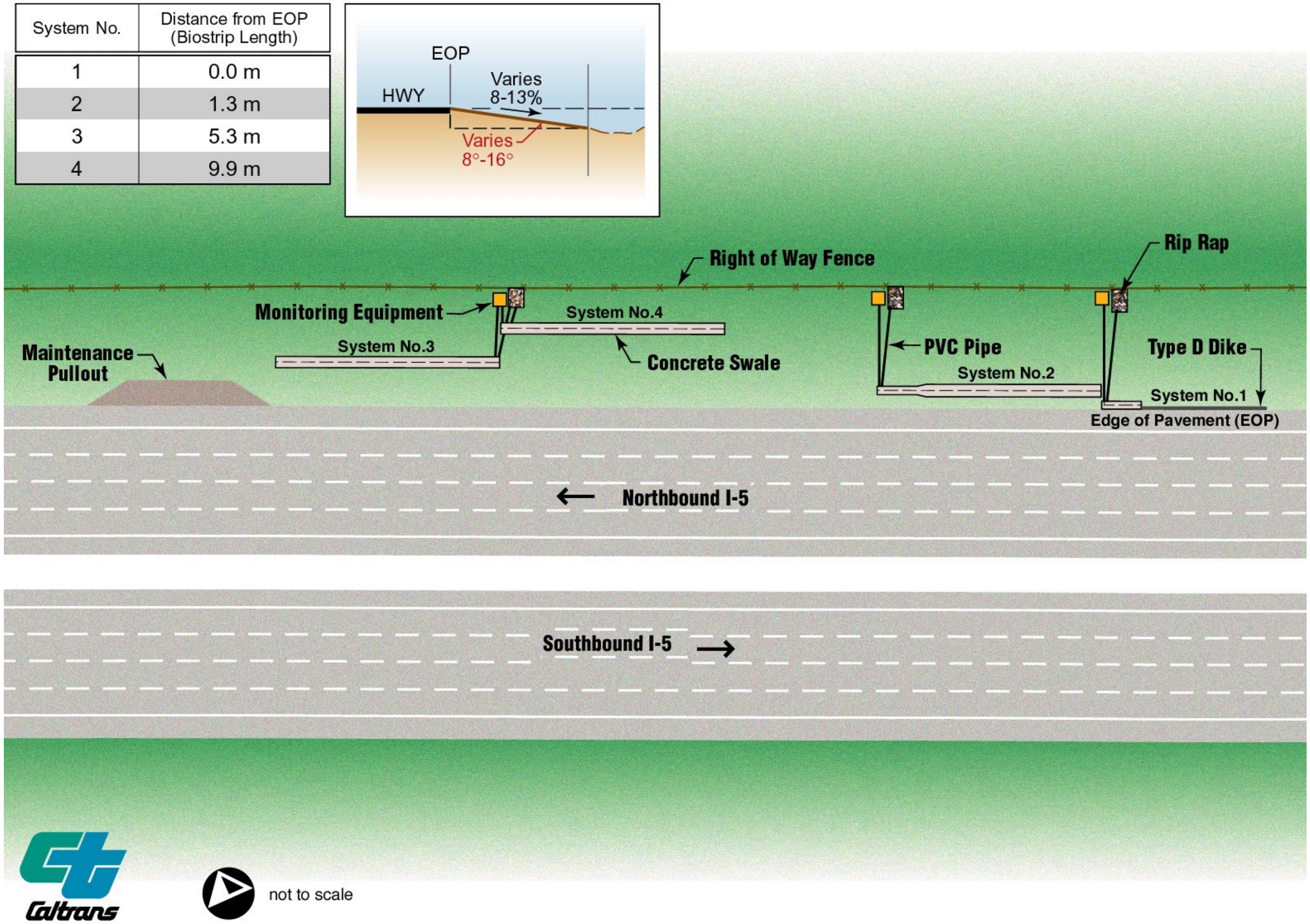
2.8 Site #8: San Onofre, I-5 (Northbound), District 11

The biofilter strip is located along the I-5 northbound before the Basilone Exit (Figure 2-9). The area can be accessed from the I-5 northbound shoulder. The site receives approximately 0.7 ac of runoff from the four lanes and shoulder of northbound I-5. The site has a slope of approximately 5 percent. The width from the edge of pavement to the end of right of way is greater than 11 m. The strip is at least 123 m in length. Grass coverage is good and extends to the edge of pavement.

Three biofilter strip collection systems and one baseline collection system were constructed at Site #8. Figure 2-9 shows a plan view of the collection systems. Each collection system consists of a 25-m long concrete V-ditch, constructed parallel to the northbound lanes of I-5. The V-ditches were positioned about 2, 5, and 10 m from the edge of pavement. The baseline collection system consists of a 25-m long concrete curb that directs the runoff to a short concrete collection channel. A-2 in, 60-degree trapezoidal flume was installed at the downstream end of each collection ditch. Monitoring equipment was installed in three separate enclosures located on concrete pads positioned about 12 m from the edge of the freeway. A 13-ft high pole was erected adjacent to each enclosure to support a solar panel and possibly a rain gauge and cell phone antenna. Lateral conveyances 50 mm in diameter were installed to bring the collected water as close as possible to the monitoring equipment.

Figure 2-9. Plan View of Site #8 (San Onofre)

System No.	Distance from EOP (Biostrip Length)
1	0.0 m
2	1.3 m
3	5.3 m
4	9.9 m



Section 3

3 CONSTITUENTS

Constituents selected for this program were based upon Table 4-1 of the *Caltrans Guidance Manual: Storm Water Monitoring Protocols* (Caltrans, July 2000). These constituents along with their analytical methods and target reporting limits are presented in Table 3-1. This list is consistent with the objectives of this program and includes common pollutants of Caltrans roads and facilities.

Table 3-1. Selected Analytical Constituents

Analyte	Analytical Procedure	Reporting Limits
Conventionals		
Hardness as $CaCO_3$	EPA 130.2	1 mg/L
Total Dissolved Solids (TDS)	EPA 160.1	1 mg/L
Total Suspended Solids (TSS)	EPA 160.2	1 mg/L
Conductivity	EPA 120.1	0.1 μmhos/cm
Temperature	Field Meter	0.1 °C
pH	EPA 150.1	0.1 units
Total Organic Carbon (TOC)	EPA 415.1	1 mg/L
Dissolved Organic Carbon (DOC)	EPA 415.1	1 mg/L
Nutrients		
Ammonia (NH_3-N)	EPA 350.3	0.1 mg/L
Nitrate as Nitrogen (NO_3-N)	EPA 300.0	0.1 mg/L
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	0.1 mg/L
Total Phosphorus	EPA 365.2	0.03 mg/L
Dissolved Ortho-Phosphate	EPA 365.2	0.03 mg/L
Metals (Total and Dissolved)		
Arsenic	EPA 206.3 or 200.8	1.0 μg/L
Cadmium	EPA 200.8	0.2 μg/L
Chromium	EPA 200.8	1 μg/L
Copper	EPA 200.8	1 μg/L
Iron[a]	EPA 200.7	25 μg/L
Lead	EPA 200.8	1 μg/L
Nickel	EPA 200.8	2 μg/L
Zinc	EPA 200.8	5 μg/L

[a] Iron is being tested at the District 2 sites only.

4 DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) Process is a strategic planning approach, based on the scientific method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that the data collection effort should satisfy. The DQO process involves determining analytes of potential concern, what types of samples to collect, how many samples to collect, when, where, and how to collect samples, required levels of precision and accuracy, and tolerable levels of error. These items are discussed throughout Sections 4 through 9 and in Appendix D. Section 4 provides a general synopsis of the planning process used to develop this monitoring program.

4.1 Composite Sample Representativeness

Immediately following sample collection, composite sample representativeness must be evaluated to determine whether samples meet the study minimum acceptable storm capture parameters (number of aliquots and percent capture). Samples not meeting these criteria are generally not analyzed. However, the Caltrans Project Coordinator will be consulted to make the decision whether or not to analyze the samples.

Percent storm capture is the percentage of the total event flow that passes the sampling station during which sample collection has occurred (i.e., the portion of the runoff represented by the composite sample). This is calculated by dividing the flow volume that passed the sampling station during sample collection by the total flow that passed the sampling station during the entire storm event.

The minimum number of sample aliquots and minimum acceptable storm percent capture depend upon the total event precipitation, as shown in Table 4-1. The specified minimum number of sample aliquots is intended to ensure adequate representativeness of the composite sample throughout the entire monitoring event. Higher numbers of sample aliquots are desirable whenever possible, subject to the practical limits of sample collection.

4.2 Reporting Limits, Precision, Accuracy and Completeness

Numerical DQOs for constituent reporting limits, analytical precision, accuracy, and completeness are summarized in Table 4-2.

Table 4-1. Monitoring Event Representativeness Requirements

Total Event Precipitation (in)	Minimum Acceptable Number of Aliquots	Percent Capture Requirement
0 – 0.25	6	85
0.25 – 0.5	8	80
0.5 – 1	10	80
>1	12	75

Table 4-2. Quality Assurance/Quality Control Objectives

Parameter	Reporting Limit	Accuracy (Recovery)	Precision		Completeness
			Matrix Spike RPD	Filed Duplicate/ Laboratory Replicate RPD	
Conventionals					
Hardness as $CaCO_3$	2 mg/L	80%-120%	-	±20%	95%
Total Dissolved Solids (TDS)	1 mg/L	80%-120%	-	±20%	95%
Total Suspended Solids (TSS)	1 mg/L	80%-120%	-	±20%	95%
Conductivity	1 µmhos/cm	-	-	±25%	95%
Temperature	± 0.1 °C	-	-	±25%	95%
pH	± 0.1 units	-	-	±20%	95%
Total Organic Carbon (TOC)	1 mg/L	85%-115%	±15%	±15%	95%
Dissolved Organic Carbon (DOC)	1 mg/L	85%-115%	±15%	±15%	95%
Nutrients					
Ammonia (NH_3-N)	0.1 mg/L	80%-120%		±20%	95%
Nitrate as Nitrogen (NO_3-N)	0.1 mg/L	80%-120%	±20%	±20%	95%
Total Kjeldahl Nitrogen (TKN)	0.1 mg/L	80%-120%	-	±20%	95%
Total Phosphorus	0.03 mg/L	80%-120%	-	±20%	95%
Dissolved Ortho-phosphate	0.03 mg/L	80%-120%	-	±20%	95%
Metals (Total and Dissolved)					
Arsenic	1 µg/L	75-125%	±20%	±20%	95%
Cadmium	0.2 µg/L	75-125%	±20%	±20%	95%
Chromium	1 µg/L	75-125%	±20%	±20%	95%
Copper	1 µg/L	75-125%	±20%	±20%	95%
Iron	25 µg/L	75-125%	±20%	±20%	95%
Lead	1 µg/L	75-125%	±20%	±20%	95%
Nickel	2 µg/L	75-125%	±20%	±20%	95%
Zinc	5 µg/L	75-125%	±20%	±20%	95%

5 FIELD EQUIPMENT INSTALLATION AND MAINTENANCE

5.1 Equipment and Installation

The storm water sampling equipment described herein is designed to measure flow and take composite samples of storm water runoff in a flow-proportioned manner. The equipment has been selected to be accurate, reliable, durable, versatile and non-contaminating. The equipment is automatic and can be accessed remotely. These features allow reductions in operating effort and increase the reliability and quality of the storm water monitoring data.

At present, there are 31 sampling points designated for the CHD Biofilter Project. The main components of the equipment to be installed at each sampling point consist of a data logger and control module, a flow meter device, an automated peristaltic sampler, a cellular modem, interface electronics, power supply, and a tipping bucket rain gauge. Most of the system's components will be used at all 31 sampling points; however, certain items will vary according to site characteristics. An overview of the main flow meter components along with all other monitoring equipment is given below, and the configuration of the equipment is illustrated in Figure 5-1.

5.1.1 Flow Control Structures

Primary flow measurement devices (i.e., flumes) are installed at all sampling points. Because primary measurement devices such as flumes constrict the liquid stream, care was taken during the design phase to size the devices according to the anticipated range of flows. Specifications for the flumes are discussed later. Flumes will be used in conjunction with a depth-measuring device. The depth-measuring devices used for this study will be of a bubbler design.

For this study, a 2-in, 60-degree trapezoidal flume has been installed at the end of each collection channel. By knowing the shape and dimensions of these flumes, flow through these structures is related to the liquid level by a mathematical relationship. Field flow verification tests will be run for calibration verification, particularly at the low-flow end of the calibration curve. The 2-in, 60-degree trapezoidal flumes can accommodate flows as great as 1.3 cfs. Flumes were constructed out of plastic or fiberglass and have a 10-ft approach section made of concrete. Since these were new construction projects, flumes were embedded in concrete.

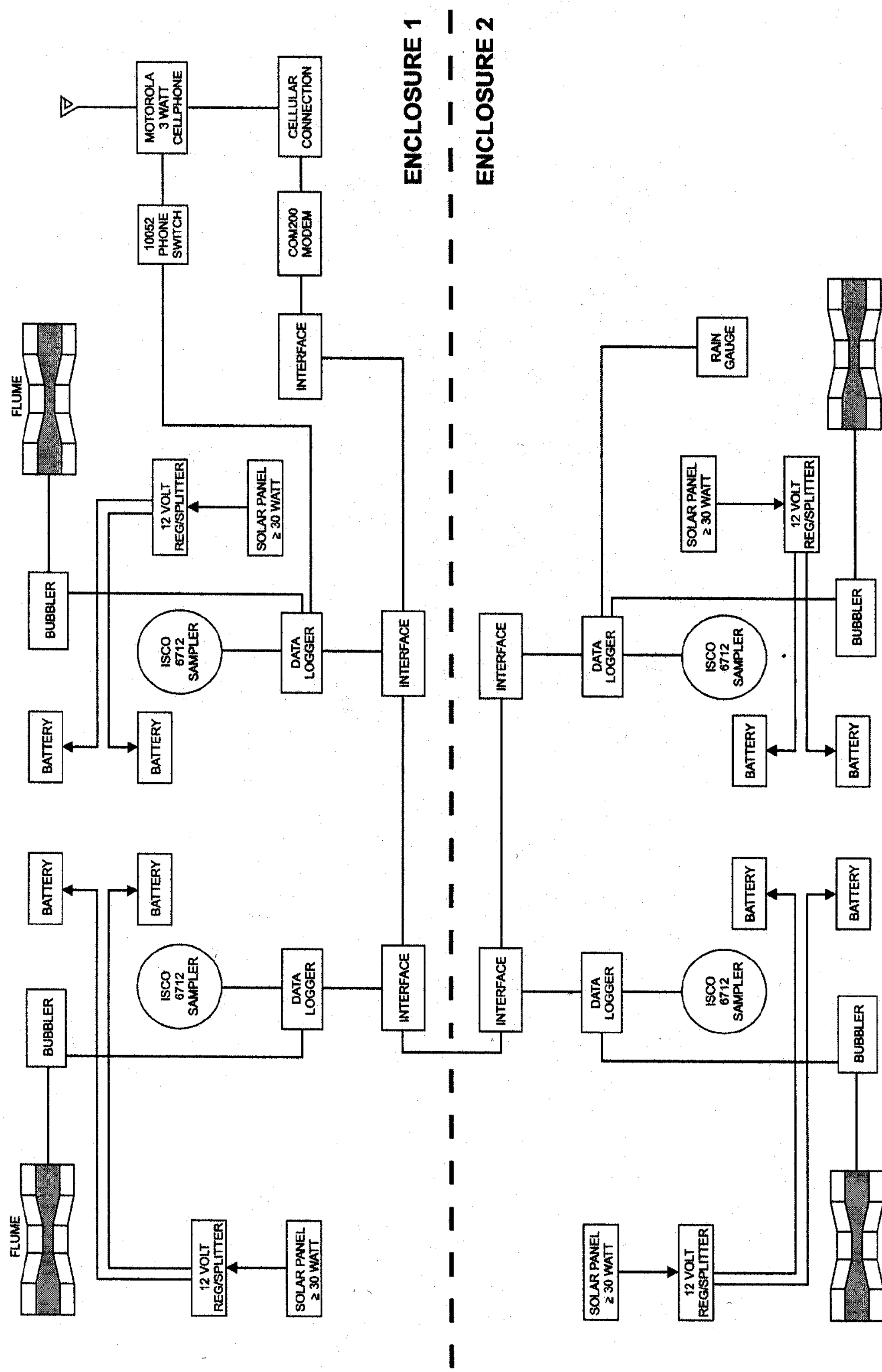


Figure 5-1. Configuration of Monitoring Equipment

5.1.2 Flow Meter Devices

In combination with the flume described above, bubbler level meters will be used to measure the liquid depth in each of the 2-in, 60-degree trapezoidal flumes. To measure water depth, a stainless steel tube is mounted at the invert of each flume at a specified measuring point. The tube is connected to a compressor and pressure transducer located on the meter device. Compressed air is fed into the tube, forcing bubbles of pressurized air out the end of the bubble tube at a constant rate. The hydrostatic pressure is measured by measuring the pressure it takes to maintain the bubble rate. In other words, the pressure in the tube can rise only until it equals the water pressure at the orifice of the tube. The water depth over the orifice is computed from the pressure in the tube. For this study, the meter device will be a Digital Control Corporation Bubbler Level Monitor (Model 12259). This device is capable of communicating to a data logger or directly to an autosampler through a 4-20 mA range output. Bubbler level meters were chosen over other depth-measuring devices because wind, turbulence, liquid, surface foam, and debris have little effect on them. Submerged pressure sensors are too bulky for this application, and they typically require the installation of stilling wells. They are also more susceptible to liquid temperature fluctuations. Ultrasonic lookdown sensors are not suitable because they would have to be mounted above the flumes where an errant vehicle could damage them.

5.1.3 Data Logging and System Control

A data logger/controller is a required component of an automatic storm water sampling station. Data logger/controllers are part of most commercially available automatic samplers, flow meters, and rain gauges. The data logger/controller provides a method of control for the sampler, storage for sampling data and other auxiliary data, and communications through a modem to a central computer. For this project, Kinnetic Laboratories will furnish existing data logger/control modules, which will connect with the statewide storm water monitoring control center and allow real-time access over the Internet. The telecommunication lines will allow cellular lines to be reduced from 31 to 8. These lines will also improve telecommunications, provide unique programming capabilities, allow for remote programming of the sampling stations, and allow for remote, automated real-time and archived data transfers.

The data loggers receive continual inputs from the flow meter devices. During rain events, the data loggers convert flow into total runoff volume. During this process, each time a preset volume of runoff passes by a monitoring station, a single electronic pulse is sent to the automatic sampler, triggering it to take a sample aliquot.

Data containing storm and hydrological information will be electronically recorded in the system data logger. Storm data records from each monitoring event will be stored separately. These records will contain information such as the intensity of flow at the time of each sample, the time and intensity of peak flow, cumulative rainfall, rainfall intensity, and discharge volumes. Hydraulic data will be recorded the entire time each system is operational. Continuous data records will be maintained in IBM PC format to allow for estimates of total flow during storm events. At a minimum, the continuous hydrological data records will record 15-minute average flow data based upon 120 measurements per hour. During storms, 1-minute average flow data will be recorded. In addition, a daily record will be logged indicating minimum and maximum flow rates for each day and the time of their occurrence.

5.1.4 Autosampler and Other Sampling Equipment

The autosamplers to be used at the CHD biofilter strip locations will be of a portable type (ISCO Model 6712) that incorporates a peristaltic pump, a liquid detector, and a base to hold a 20 L sample bottle and ice. In flow-proportioned compositing mode, the pump will deliver a self-calibrated sample volume when signaled by the data logger/controller. For this study, each sample aliquot size will be 250 mL. The ISCO 6712 sampler can be interfaced with a variety of flow meter devices.

The suction hose used with the sampler will be 3/8 in pure Teflon® tubing. Therefore, the sampler is equipped with 3/8 in peristaltic tubing and a 3/8 in stainless steel intake strainer of low-flow design. These strainers will be attached, using stainless-steel fasteners, to the invert of each of the PVC lateral conveyances or upstream of the flume within the approach channel.

The sample collection bottles will hold 20 L of captured runoff and be made of borosilicate glass with Teflon stoppers. Borosilicate glass is suitable for both trace organic and inorganic analyses.

5.1.5 Telecommunications

Landline telephone service is not available in the Caltrans rights-of-way. Therefore, Motorola cellular modem transceivers will be used to provide telecommunication access to the monitoring sites. The modem in the device is optimized for the higher error rates encountered in the noisy environment inherent in cellular communications, and the intelligence in the transceiver is utilized to minimize the noise. Therefore, the combination modem/cellular transceiver provides a much more error-free communications channel than a standard modem coupled with cellular telephone.

Instead of separate cellular lines and modem transceivers for each sampling point, the design for this program will utilize only one per site. This will greatly reduce complexity, costs, and power needs and will increase reliability. The data logger assigned to each sampling point at each location will be linked to the single cellular modem transceiver via cabling and interface electronics. This configuration will allow access to the data at each sampling point at each site through a single phone call using a single phone number.

A high performance base station antenna will be installed at the top of a 13-ft mast that also supports solar panels and possibly a rain gauge. A filter will be installed in the lead-in from the antenna to prevent damage to the sampling station equipment in the unlikely event of nearby lightning strikes.

5.1.6 Rain Gauges

The rain gauges to be used for the CHD Biofilter Project will be of tipping bucket design. A tipping bucket rain gauge incorporates a small "bucket" which holds a known amount of rainfall. When the bucket fills, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used for this program are manufactured by ISCO and will tip after every 0.01 in of rain. One rain gauge will be installed at each of the locations on top of a 13-ft mast used for the support of solar panels.

5.1.7 Power

Power for the monitoring stations will come from 12 V, deep-cycle marine batteries. A separate battery will be used to individually power the autosamplers, modems, and bubbler flow meters. A 30 W solar panel will be installed for each sampling point to keep the batteries charged. The single telecommunication station at each biostrip location will greatly reduce power required, the number of batteries, and maintenance.

5.1.8 Site Enclosures

Two sizes of steel utility boxes will be used for this project. The larger boxes, 48 in x 36 in x 48 in (L x W x H), will house two sets of samplers and associated electronic equipment. The smaller boxes, 36 in x 30 in x 36 in (L x W x H) will be used for those sampling points that cannot be located adjacent to another sampling point. Boxes will be bolted to concrete pads and locked to secure the monitoring equipment.

5.1.9 Installation

Experienced field teams will install the equipment with intakes and sensors securely mounted, tubing and wires in conduits, and all above ground instruments protected within a security enclosure. A 1.5-m^2 concrete pad will support the security enclosures. Conduit, for the most part, will be hidden in short, shallow trenches. Exposed conduit, intakes, and sensors will be securely fastened using stainless steel brackets, screws and anchors.

The poles to support rain gauges, solar panels, and antenna will be constructed out of 2 in heavy-wall galvanized pipe with direct connections to the security enclosures. The base of the pole will be attached to the concrete pad with a floor flange. Each pole will be 13 ft high. Components of the monitoring equipment will undergo calibration and verification during installation and during maintenance and pre-storm visits.

5.2 Maintenance Of Sampling Equipment

A complete maintenance program will be performed at each sampling station after each storm event during the monitoring period, or monthly in the absence of rain. Maintenance will include checking the performance of all the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing any necessary equipment calibrations.

Maintenance visits will be thoroughly documented. Inspection forms included in Appendix C will be filled out during each maintenance visit. These forms include inspections for both the monitoring equipment and biofilter strips. Written documentation includes the action taken at a site and the date performed. Accurate records will always be maintained of every station visit.

5.3 Rain Covers

The size of each concrete V-ditch collection system relative to its upstream tributary area is significant. To minimize the effect of runoff generated from rain falling directly into the concrete V-ditch collection systems, fiberglass rain covers were fabricated for each V-ditch collection system; these covers are installed before and removed after each wet season.

5.4 Encroachment Permit and Restrictions

Depending on the Caltrans District, visitation to a monitoring site requires a Caltrans Encroachment Permit. This permit lists access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Offices will be contacted for further information and direction.

6 PREPARATION AND LOGISTICS

6.1 Weather Tracking

Weather will be tracked for monitoring beginning October 1, 2002 until April 30, 2002. Throughout the storm season, several sources for weather information will be monitored continuously. Internet web pages for the National Weather Service and local ALERT systems will be monitored. In addition, custom forecasting will be received from a private weather forecasting service. This service will be available on an as-needed basis just prior to and during monitored events.

6.2 Storm Selection Criteria

The criteria listed below will be used to determine whether or not to monitor an impending event. Figure 6-1 is a flow chart denoting the mobilization decision process.

- All storms monitored must be forecasted to produce at least 0.25 in of rain.
- The probability of precipitation must be greater than 70 percent for a decision to be made without Caltrans consultation.
- Caltrans must be consulted prior to monitoring storms with a probability of precipitation less than 70 percent or less than 0.25 in of rain.
- Storm events must be preceded by at least 72 hr of dry conditions (<0.1 in of precipitation) unless otherwise directed by Caltrans personnel.

6.3 Storm Action Levels

Throughout the storm season, action levels adapted from the *Caltrans Guidance Manual: Storm Water Monitoring Protocols* (Caltrans, July 2000) will be followed. These action levels are shown in Figure 6-1.

6.4 Mobilization and Staffing

Storm monitoring requires considerable planning prior to any actual rainfall. Obtaining representative samples and complete storm data is only possible with well-trained and alert field teams. The uncertainty of weather forecasts coupled with abrupt changes in the weather can greatly alter the expected workload. This can lead to fatigue and frustration of all personnel involved. It is therefore critical to plan and prepare all possible aspects of the field effort well in advance. A Staffing Plan, which designates personnel and equipment for each facet of storm monitoring, should be completed as soon as a potential event is forecast (see Figure 6-2 for an example).

Figure 6-1. Storm Selection/Monitoring Action Levels

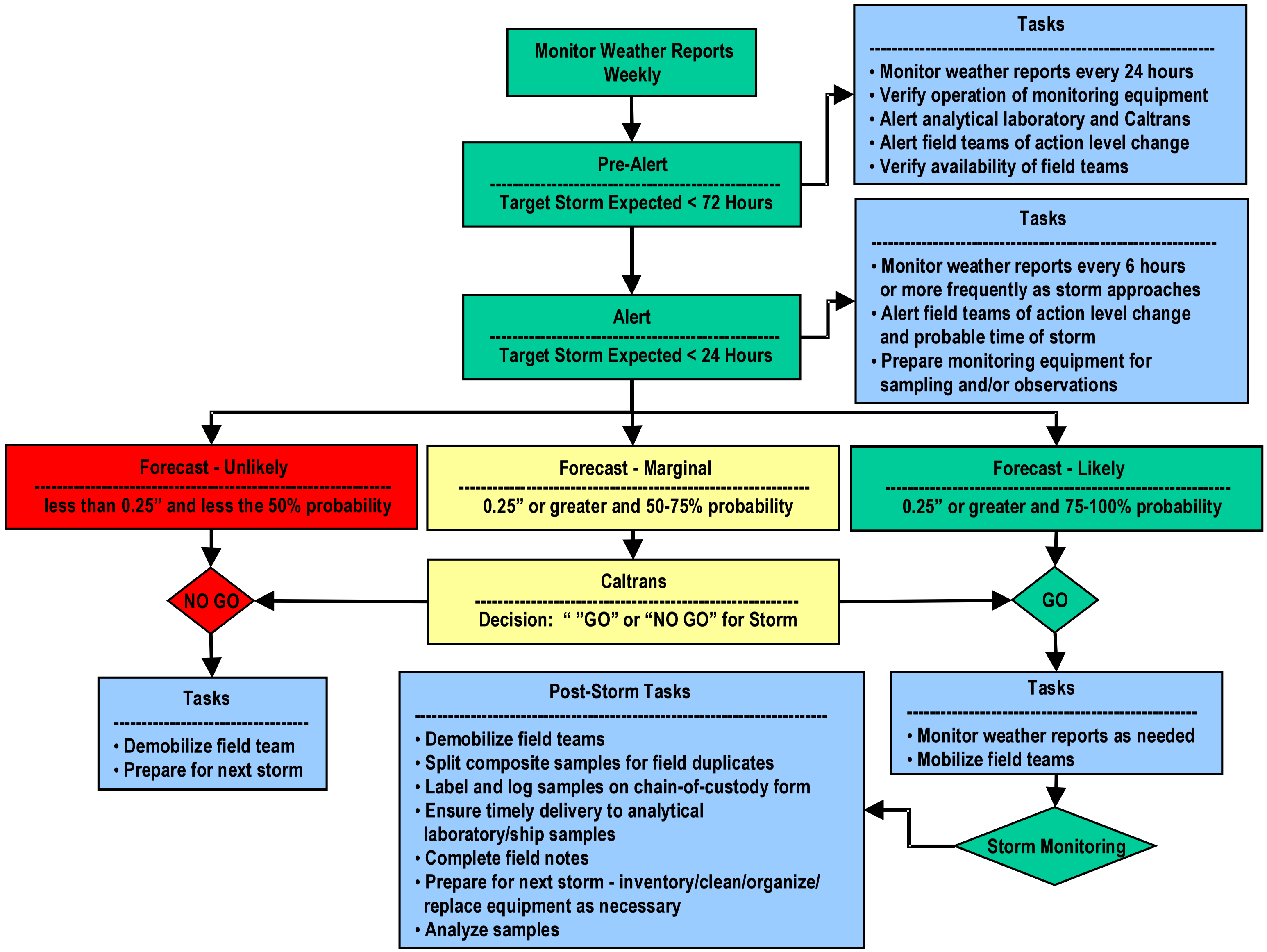


Figure 6-2. Storm Staffing Plan

Caltrans Storm Water Sampling		**Storm Date:**	
Zone #1	Zone #2	Zone #3	Zone #4
Estimated Start:		**End Time:**	
Storm Control:		Phone Number:	
Shift Leader:		Phone/Radio:	
Zone #1 Startup	**Zone #2 Startup**	**Zone #3 Startup**	**Zone #4 Startup**
Team	Team	Team	Team
Vehicle	Vehicle	Vehicle	Vehicle
Phone/Radio	Phone/Radio	Phone/Radio	Phone/Radio
Relief Start:		**Relief End:**	
Storm Control:		Phone Number:	
Shift Leader:		Phone/Radio:	
Zone #1 Relief	**Zone #2 Relief**	**Zone #3 Relief**	**Zone #4 Relief**
Team	Team	Team	Team
Vehicle	Vehicle	Vehicle	Vehicle
Phone/Radio	Phone/Radio	Phone/Radio	Phone/Radio

Because of the distances involved between the CHD biofilter strip locations, seven teams (Sites 2 and 3 can be monitored by one team), each made up of two individuals, will be activated for each storm event. The Staffing Plan should include the following information:

- Personnel needed for each position
- Shift and zone designations
- Equipment mobilization
- Communication channels

6.4.1 Personnel

Personnel scheduling is best accomplished if one begins by creating a list of personnel resources. Storm monitoring tasks require a variety of skills and positions; the required personnel include:

- Storm Controller
- Shift Leader
- Team Chiefs
- Team Assistants

The development of a well-trained and experienced pool of Storm Control personnel is of utmost importance to successful storm water monitoring. The function of Storm Control is to monitor the status of the monitoring stations via telecommunications and enter any necessary program commands. Storm Control must be able to obtain and interpret the most recent weather forecasts to determine the appropriate "Volume to Sample" values (volume of runoff for each sample aliquot) as well as make informed decisions regarding the storm status. It is also the responsibility of Storm Control to notify all personnel if shift start and end times change.

The Storm Controller will be required to have excellent decision-making and dispatch skills. This position should be filled by the Task Order Manager or designated assistant who understands the requirements of the CHD Biofilter Evaluation Program. If an assistant fills this position, the Task Order Manager should be available to answer questions.

The Shift Leader is a technically skilled field supervisor, and is generally the most experienced of the Team Chiefs. This position requires a thorough understanding of project requirements, sampling procedures, and equipment operations. The Shift Leader will communicate frequently with Storm Control to determine task priorities. The Shift Leader will also monitor the ability of field teams to safely and effectively complete their shifts and notify Storm Control of the need for relief teams. The Shift Leader must be able to troubleshoot most of the common problems that could be experienced by any of the field teams. The Shift Leader will also provide on-site weather observations for Storm Control.

The Team Chiefs are field personnel trained in the operations and the procedures of storm water monitoring. The Team Chief is responsible for directing the procedures at each site visit and ensuring that data is recorded properly. The Team Chief will communicate with Storm Control and the Shift Leader to aid in the determination of task priorities. The Team Chief will usually have one or two Team Assistants. Team Assistants are field personnel who may or may not have received extensive training on the procedures of storm water sampling.

6.4.2 Equipment Mobilization

Equipment needed for storm water sampling includes all sampling equipment and containers, safety equipment, personal rain gear, storm kits and vehicles equipped with some type of mobile communication and highway safety equipment (Table 6-1). The necessary equipment should be loaded into the appropriate vehicles early in the storm preparation sequence.

6.4.3 Communication Channels

Communication channels must be established for personnel to contact each other before and during the event. Phone lists with home and work numbers should be made available to potential field team members. Two-way radio or cellular telephone communication links to field teams are essential for efficient storm water monitoring since the Storm Controller and the Shift Leaders will need to track the location and workload of each field team and direct them to priority tasks. Radio channels or cellular telephone numbers to be used during sampling should be part of the Staffing Plan.

Table 6-1. Storm Kit Equipment and Mobilization List

Storm Kit Equipment List	Mobilization List
Keypad/display	Storm kit
9 pin cable from keypad to datalogger	Log books
Full set of keys	Thermometer (to be left onsite in edge of pavement monitoring station enclosure)
Flashlights (2)	Paper towels
Maps for all required areas	Tape gun with clear tape
Large flat screwdriver	Spare sample labels
Small flat screwdriver	Ice scoop
High-quality alkaline D-cell batteries	Sample control paperwork
Spare sample labels	Extra fine indelible markers
Pencils and indelible markers	20 L bottles in specially fabricated ice chests
Desiccant (packages and jar)	Reagent grade analyte-free deionized water (3 gal jug) from the laboratory
Diagonal clipper	Two-way radio or cellular phone
Electrical tape	Personal rain gear
Cable ties (assorted sizes)	Digital or disposable camera
Utility knife	Any necessary safety gear (see Appendix B - *Health and Safety Plan*)
Ziplock baggies (assorted sizes)	
Labeling tape	
Polyethylene gloves	
Rubber bands	

6.5 Station Preparation

Prior to a storm event, stations must be made ready to sample. This preparation includes entering the correct "Volume to Sample" values, setting the autosamplers and the data loggers to sampling mode, pre-icing the composite sample bottles, and performing general equipment inspections.

6.5.1 Determination of "Volume to Sample"

The latest weather forecast prior to each storm event (within 24 hours of storm event occurring) should be examined to determine the proper "Volume to Sample" value to enter into the system. Be sure to take into consideration the amount of expected rainfall, how the station performed during the previous storm and how much water is needed at the station for each storm event.

The "Volume to Sample" is entered as a number with units in kilo cubic feet (kcf). To determine this number, one must determine the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area. Use the following equation to determine the volume of water expected at a particular station for a given rainfall:

$$P \times A \times C \times 3.63 = \text{volume in kcf}$$

P = in of rainfall
A = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

System Location	Runoff Coefficient
Edge of pavement	0.92
2 m strip	0.82
5 m strip	0.72
8 m strip	0.62
13 m strip	0.52

Divide this result by the number of samples needed to satisfy the water volume requirement for analysis to determine how much water should pass the station between samples. A table will be made up that indicates the "Volume to Sample" value needed to collect the correct amount of water for any given rainfall.

Once the proper "Volume to Sample" value is determined, it must be entered into the monitoring station data logger before the storm starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system will sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

6.5.2 Prepare Sampler

Make sure that the autosampler has been reset and that it has been programmed to take the desired number of sample aliquots.

6.5.3 Ice Sample Bottle

If possible, the sample bottle should be iced after the decision has been made to monitor the storm. If this is not possible, the bottle should be iced immediately upon the first visit.

6.5.4 General Inspection

The equipment and site should be physically inspected to make certain that there are no obvious problems such as damaged or missing equipment, broken conduit or a kinked hose. Intake strainers should be cleared of debris. Collection system channels should be cleared of trash and debris (leaf blower use suggested).

6.5.5 Documentation

At the time of a site visit, whether during storm mode or not, records of the visit must be accurately recorded in the field log. Use the log sheet as a guide for the exact data needed, and fill in every necessary blank (see Figure 6-3). Whenever possible, verify any data being recorded (for example, time or current stage).

The following general information should be filled in during each site visit:

- Alphanumeric station ID
- Date
- Julian day
- Station name
- Field team
- Time (arrival and departure)
- Weather conditions
- Turbidity of the runoff
- Runoff causing erosion
- Oil
- Floating material
- Other observations

Figure 6-3. Field Data Log Sheet

GENERAL INFORMATION

Caltrans Monitoring Site ID_________________ Calendar Date_____________________

CHD Location Name______________________

Station ID (*6-21A)_______________________

Time (*5): Arrival___________PST (no light savings)

Departure_________PST

Date (*5AA) Julian Day ________.

Field Crew Names ____

(*An Empirical Observation Log must be filled out during all storm visits*)

SYSTEM STATUS FLAGS (*6-AD; 1=high, 0=low) **PROGRAM SIGNATURE** (*B)

Arr: 1____ 2____ 3____ 4____ 5____ 6____ 7____8____ Arr:

Dep: 1____ 2____ 3____ 4____ 5____ 6____ 7____8____ Dep:

STATION DATA (*6-XXA)

All Site Visits:		**Storm Site Visits:**			
Temp. (C)	01:	Volume (kcf)	05:	MaxFlow (day)	51:
Stage (ft)	02:	Vol. Sum (kcf)	06:	MaxFlow (time)	52:
Q (cfs)	04:	Percent Capture	08:	MaxFlow Q	53:
Station ID	21:	Estimated Rain	09:	Total Strm. Vol.	72:
CR-10 Batt.	22:	VolumeToSample	14:	Strm. Vol. Smpld.	75:
Sampler Batt.	36:	Sample Count	17:	Last Sample (day)	105:
Bubbler Batt.	37:	Total Rain (in.)	25:	Last Sample (time)	106:
Cell Batt.	82:				

SAMPLER INFORMATION (Storm only) Bottle # out:

Sample ___ after 1 pulse Bottle Volume: Bottle # in:

Record Each Missed Sample Number (aliquot number)

MANUAL WATER QUALITY MEASUREMENTS (Storm only)

Water Temperature (°C) ____________________________

Thermometer Number ______________________________

Rain Gauge Reading (in) ____________________________

Water Depth in Flume (ft) __________________________

ACTIONS TAKEN :

Team Leader's Signature _____________________________________

During each station visit, several display locations must be recorded. Use the log sheets as a guide to the proper display locations to record, as each station may have its own unique set of data. In general, however, the following data are needed at each station:

- Temperature
- Data logger stage
- Velocity (f/s)
- Q (flow in cfs)
- Station ID
- Datalogger battery voltage
- Flow meter battery voltage
- Cellular phone battery voltage

Additional data must be recorded in the logbooks during storm monitoring. Use the log sheet for the station being visited to determine the necessary information. The following data are uniform throughout all of the stations:

- Volume (kcf)
  Volume of water that passed the station during the previous execution interval (1 min).
- Storm Sum
  Accumulated runoff volume in kilo cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  Percent of the storm effectively sampled by the monitoring equipment; also provides a quick evaluation of the quality of the monitoring.
- Volume-to-Sample
  Runoff volume (in kcf) that must pass the station before the monitoring equipment will take the next sample.
- Sample Count
  Number of samples taken in the current bottle; automatically re-zeroes every time a bottle is filled.

- Total Rain (inches)
  Total rainfall in inches since the start of the storm; accumulated each time the rain bucket tips.

- Max Flow (day)
  Julian day on which the maximum flow occurred.

- Max Flow (time)
  A positive number indicates that the system was sampling during peak stage; a negative number indicates that sampling did not occur during the peak stage because the bottle was full.

- Max Stage (feet)
  Depth of the maximum stage during the current storm.

- Max Flow (cfs)
  Maximum flow rate during the current storm.

- Storm Volume (kcf)
  Total volume of water that has flowed past the station since the beginning of the storm.

- Storm Volume Sampled (kcf)
  Total volume of water that flowed past the station while the system has been in storm mode

6.5.6 Training

Field personnel will be properly trained in the use of the monitoring equipment and clean sample handling techniques along with all appropriate health and safety protocols. Specifically, the following elements will be included in the training of all field personnel:

- Review of Sampling and Analysis Plan

- Review of Health and Safety Plan

- Classroom training

- Field training

7 SAMPLING, LABORATORY PREPARATION, AND ANALYTICAL METHODS

7.1 Storm Monitoring (Field)

A priority objective of storm water monitoring is to maximize the percent storm capture of the composite sample. This is accomplished by ensuring that a composite bottle does not fill without being changed immediately. If a bottle does fill, the full sample bottle must be replaced and the system must be reset. In order to determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted, the "Storm Sum" and the "Volume to Sample" should be evaluated. By examining how quickly the "Storm Sum" value is approaching the "Volume to Sample" value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. Each field team must be aware of the current status of each of its stations to determine which one will fill a bottle first so they can be on site as the bottle fills. If the station has been set properly for the amount of rainfall, changing the composite bottle should not be necessary. "Volume to Sample" settings should take into account the volume of sample required to meet all analytical needs. This study requires approximately 5 L of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated "Storm Sum" equals the "Volume-to-Sample." The "Storm Sum" is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the "Volume to Sample" value will be accurate for the amount of rainfall, and the bottle will not need to be changed during the storm. If, however, the rainfall is different than that predicted, a bottle might fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. Until the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain the required percent storm captured as listed in Table 4-1. The sample collection procedures are described in Appendix D.

7.2 Empirical Observations

Performance assessments of the CHD Biofilter Evaluation Program cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of the CHD biofilter strip. Some of these factors such as rainfall quantity and rainfall intensity can and will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, gopher burrowing, and runoff appearance can be best assessed through careful documented observations.

Observations will be succinct but also complete. For a biofilter performance evaluation, the following observations will be made:

- Rainfall (start and end times, time since last rain, and intensity indication)
- Presence of runoff (quantity)
- Standing water
- Flow conditions
- Sediment deposition
- Condition of vegetation
- Presence of erosion
- Condition of equipment
- Trash loads
- Presence of fauna
- Flow entering facility evenly, without bypass for a 'design event'

Appendix C contains a log form that will be completed by sampling and monitoring personnel during every storm visit to the facility and during each post storm visit. Quarterly log forms will be completed during equipment maintenance visits or quarterly.

7.3 Laboratory Selection

Pat-Chem Laboratories, located in Moorpark, California, will conduct laboratory analyses. Pat-Chem Laboratory has extensive experience with storm water studies and has the ability to provide rapid response to meet critical holding time requirements for constituents requiring expeditious analyses (see Table 7-1).

Table 7-1. Shipping Locations and Methods

Site No./Location	Shipping Method[1]
1 Sacramento	Right Now Courier, telephone 877-222-8528
2 Cottonwood	
3 Redding	
4 San Rafael	
5 Yorba Linda	Samples consolidated at URS Santa Ana Office and then picked up by Pat-Chem Laboratories. Backup: URS staff to deliver to Pat-Chem Laboratories.
6 Irvine	
7 Moreno Valley	
8 San Onofre	

[1]Pat-Chem Laboratories is located at 11990 Discovery Ct., Moorpark, CA 93021, telephone (800) 400-LABS or (805) 732-7356 or (805) 340-1408.

URS Santa Ana Office is located at 2020 East First St., Suite 400, Santa Ana, CA 92705, and telephone (714) 835-6886

7.4 Holding Time, Sample Volumes and Preservation Requirements

The laboratory will be responsible for providing appropriate sample containers and, where necessary, preservatives for each analysis. Table 7-2 provides a summary of sample volumes required for each analysis. Since additional volumes are necessary for laboratory QA/QC, sample containers preferably provide at least twice the volume necessary to perform the analysis. The volume of the storm water composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. The Task Order Manager and/or Sample Control will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide additional volume for each analysis.

Some constituents (i.e., nitrate, dissolved ortho-phosphate, and dissolved metals) have critical holding time requirements of 48 hours. This will require close coordination between the laboratory and sampling team to assure that these analyses are completed within holding times. With composite samples, the start of holding times is considered to be the time that the last aliquot was collected.

7.5 Project Detection Limits

Recommended analytical methods and detection limits for this project are listed in Table 7-3. The detection limits in this table are target detection limits. In some cases, detection limits may need to be adjusted due to limited sample volumes or potential matrix interferences. In such cases, appropriate data qualifiers will be applied to the associated data.

7.6 Sample Labeling

Sample bottles will be pre-labeled to the extent possible before each storm water monitoring event. Pre-labeling bottles simplifies field activities, and leaves only date, time, sample number and sampling personnel names to be filled out in the field. Each sample collected will be labeled with the following information:

- Project Name
- Station Name
- Date and Time
- Sample ID Number
- Sample type (composite)
- Bottle __ of __ (for multi-bottle samples)
- Collected by
- Preservative
- Analysis

Field samples, field blanks, and field duplicate samples will be labeled as described as described below. These samples will be labeled, recorded on the Chain-of-Custody Form, and then transported to the analytical laboratory.

Each storm water sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for all samples and contain information as it relates to the site, date of sample collection, and type of sample. The required sample identification numbers are listed below along with an example for the first sampling event at a site.

- SITE# = Site ID Number [refer to Table 2-1 (e.g., 8-201)]
- 0212051440 = Year, month, day, and military time (YYMMDDTTTT)
- 00# = Sample type
- 000 = Primary sample
- 500 = Field duplicate sample
- 600 = Field blank

Field Sample	**Field Duplicate Sample**	**Field Blanks**
8-201-0212051440-000	8-201-0212051440-500	8-201-0212051440-600

Matrix spike/matrix spike duplicate (MS/MSD) samples and samples identified for Laboratory Replicate Analysis will be clearly noted on the Chain-of-Custody Form. No special sample identification numbers are required.

7.7 Laboratory Data Package Deliverables

Laboratories will be required to provide a 3-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical problems, QA/QC exceedances and corrective actions. The electronic data files will contain all information found in the hard copy reports submitted by the laboratory in accordance with the format required for processing with the Caltrans Automated Data Validation Software. Individual data sets may be submitted to URS as either Microsoft Excel workbook files or as Microsoft Access database files.

Table 7-2. Holding Time, Volume Containers and Preservation for Each Recommended Constituent

Analyte	Holding Time	Minimum Sample Volume[a]	Container Type	Preservation
Conventionals				
Hardness as $CaCO_3$	6 months	100 mL	Glass or Plastic	4°C , $HN0_3$ or H_2SO_4 to pH < 2
Total Dissolved Solids (TDS)	7 days	100 mL	Glass or Plastic	4°C
Total Suspended Solids (TSS)	7 days	100 mL	Glass or Plastic	4°C
Conductivity	Immediately	250 mL	Glass or Plastic	4°C; filter if hold time > 24 hrs
Temperature	Field Measurement			
pH	Immediately	50 mL	Glass or Plastic	4°C
Total Organic Carbon (TOC)	28 days	250 mL	Glass	4°C and HCl or H_2SO_4 to pH<2
Dissolved Organic Carbon (DOC)	28 days	250 mL	Glass	4°C and HCl or H_2SO_4 to pH<2
Nutrients				
Ammonia (NH_3-N)	28 days	500 mL	Glass or Plastic	4°C and H_2SO_4 to pH<2
Nitrate as Nitrogen (NO_3-N)	48 hr	200 mL	Glass or Plastic	4°C
Total Kjeldahl Nitrogen (TKN)	28 days	500 mL	Glass or Plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	28 days	100 mL	Glass or Plastic	4°C and H_2SO_4 to pH<2
Dissolved Ortho-Phosphate	48 hr	100 mL	Glass or Plastic	4°C; filter immediately
Metal[b,c] (Total Recoverable and Dissolved) Arsenic, Cadmium, Chromium Copper, Iron[d], Lead, Nickel Zinc	6 months (filter for dissolved fraction and preserve within 48 hrs; 6 months to analysis)	1 L	Teflon, Plastic or Borosilicate Glass -	4°C and HNO_3 to pH < 2[c]

[a] Parameters with like preservatives can be combined into a single container if the same lab is performing the analyses. For example, TDS, TSS, turbidity, conductivity, and pH can be put in a single 1 L plastic container.
[b] All metals are collected in a single container.
[c] Filter dissolved samples before preservation.
[d] Iron is being tested at the District 2 sites only.
= Not Applicable.

Table 7-3. Detection Limits for Each Recommended Constituent

Analyte	Target Detection Limit	Target Detection Units	Analytical Technique	Method Number
Conventionals				
Hardness as $CaCO_3$	2.0	mg/L	titrimetric/colorimetric; calculation	EPA 130.2; 130.1; SM 2340B
Total Dissolved Solids (TDS)	1.0	mg/L	dried filtrate weight	EPA 160.1
Total Suspended Solids (TSS)	1.0	mg/L	dried filter weight	EPA 160.2
Conductivity	1.0	μmhos/cm	conductivity meter	EPA 120.1
Temperature	0.1	°C	thermistor, thermometer; thermophone	SM2550
pH	0.1	std. units	Electrometric	EPA 150.1
TOC	1.0	mg/L	oxidation or combustion	EPA 415.1
DOC	1.0	mg/L	oxidation or combustion	EPA 415.1
Nutrients				
Ammonia (NO_3-N)	0.1	mg/L	titrimetric/potentiometric	EPA 350.2; 350.3
Nitrate as Nitrogen (NO_3-N)	0.1	mg/L	ion chromatography	EPA 300.0
Total Kjeldahl Nitrogen (TKN)	0.1	mg/L	titrimetric/colorimetric/ potentiometric	EPA 351.3
Total Phosphorus	0.03	mg/L	Colorimetric	EPA 365.2
Dissolved Ortho-Phosphate	0.03	mg/L	Colorimetric	EPA 365.2; 365.3
Metals (Total Recoverable and Dissolved)				
Arsenic	1.0	μg/L	GH-AA; ICP-MS	EPA 206.3; 1632[a;] 200.8
Cadmium	0.2	μg/L	GF-AA; ICP-MS	EPA 213.2; 200.8[b]
Chromium	1.0	μg/L	GF-AA; ICP-MS	218.2; 200.8[b]
Copper	1.0	μg/L	GF-AA; ICP-MS	220.2; 200.8[b]
Iron [c]	25	μg/L	GF-AA; colorimetric	236.1; 200.7[b]
Lead	1.0	μg/L	GF-AA; ICP-MS	239.2; 200.8[b]
Nickel	2.0	μg/L	GF-AA; ICP-MS	249.2; 200.8[b]
Zinc	5.0	μg/L	GF-AA; ICP-MS	289.2; 200.8[b]

[a] EPA method 1632 is an additional available "clean-technique" GH-AA method that can be used for this constituent. EPA method approval is in progress.
[b] EPA method 1638 is an additional available "clean-technique" ICP-MS method that can be used for this constituent. EPA method approval is in progress.
[c] Iron is being tested at the District 2 sites only.

Section 8

8 QUALITY ASSURANCE/QUALITY CONTROL

This section addresses Quality Assurance/Quality Control (QA/QC) activities associated with both field sampling and laboratory analyses. The field QA/QC samples are used to evaluate potential contamination and sampling error introduced prior to submittal to the analytical laboratory. Laboratory QA/QC activities provide information needed to assess potential laboratory contamination, analytical precision and accuracy, and representativeness.

8.1 Field Quality Assurance/Quality Control

A set of QA/QC samples for each storm event must be provided with each type of sample that is to be analyzed. The analytical laboratory may also require more QA/QC samples if one type of analysis is to be run in more than one batch. The main types of QA/QC that will be utilized for this study are as follows:

1. **Blanks** - These are for field as well as laboratory samples. Sample bottles are filled with reagent grade analyte-free deionized water. The analytical laboratory is then required to perform a specific suite of analyses from these sample bottles. This helps verify that the equipment and the sample containers are not contaminated, and also that the techniques used are non-contaminating.

2. **Duplicate Analyses** - These analyses will require an additional set of sample containers to be sub-sampled in conjunction with a known site. When analyzed, they will allow evaluation of sampling error introduced by both field sampling and laboratory analyses.

3. **Matrix Spike and Matrix Spike Duplicate (MS/MSD)** - The laboratory will require additional sample volumes for analyses that require matrix spikes and spike duplicates to evaluate precision and accuracy of the laboratory analytical method. MS/MSDs are analyzed for their known constituents and then spiked with a known amount of analyte.

4. **Laboratory Replicate/Split** – This is also part of the QA/QC analysis and will require additional sample volume. This sample is a duplicate analysis performed on the same sample container and proves the repeatability of the analytical laboratories' results.

The blank samples, duplicate samples, MS/MSDs and splits need not all come from the same station during a particular storm event. However, per storm event (or batch run), each of these QA/QC analyses will be provided along with the standard analyses if enough sample volume has been collected. A complete set of field QA/QC samples during the 2002/03 wet season will be targeted for each sampling station. Most field QA/QC samples are submitted blind to the analytical laboratory; however additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and spike duplicates must be clearly identified. Table 8-1 summarizes the recommended QC sample frequency.

Table 8-1 Recommended Quality Control Sample Frequency

QA/QC Sample Type	Minimum Sampling Frequency	Constituent Class
Field Duplicate	Once every ten samples collected at a given site or once per sampling station per project, whichever is more frequent.	All
Lab Duplicate	Once every ten samples collected at a given site or once per sampling station per project, whichever is more frequent.	All
Equipment Blank	Equipment blanks should be collected prior to each sampling season for each piece of equipment to be used for sample collection (tubing, strainers).	Metals and other common contaminants.[1]
Bottle Blank	Composite and sample bottles should be blanked every batch[2] at a 2% frequency; or manufacturer or laboratory-certified to concentrations below the reporting limits used for the sampling program.	Metals and other common contaminants. [1]
Field Blank	Once every ten samples collected at a given site or once per sampling station per project, whichever is more frequent.	Metals and other common contaminants. [1]
Matrix Spike/Matrix Spike Duplicate	Once every ten samples collected at a given site or once per sampling station per project, whichever is more frequent.	Metals and other common contaminants. [1]

Reference: *Caltrans Guidance Manual: Stormwater Monitoring Protocol, Second Edition, revised July 2000*
Notes:
(1) Other common contaminants include phthalate compounds, pesticides, organic carbon (TOC and DOC), nitrate as N, and PAHs. Analyze blanks for these constituents as appropriate for constituents monitored in specific projects.
(2) A batch is defined as the group of bottles that have been cleaned at the same time, in the same manner; or, if decontaminated bottles are sent directly from the manufacturer, the batch would be the lot designated by the manufacturer in their testing of the bottles.

8.1.1 Composite Samples

Upon completion of the storm sampling, the 20-L composite sample bottles will be sub-sampled into the appropriate sample containers by the analytical laboratory. The sample containers will be labeled and accompanied by all appropriate sample handling and tracking paperwork.

The analytical suite for each station depends upon the total volume of water collected for the storm event. When insufficient volumes have been collected, Sample Control will need to coordinate with the analytical laboratory to approve analysis of the storm water. A Priority Analysis Sheet is used in conjunction with a Composite Sample Bottle Evaluation to determine the analytical suite for each station based on the volume of water collected at that station, the "Volume to Sample," and the percent storm capture. Once the storm has been evaluated and each 20-L bottle volumes recorded, a duplicate station and a QA/QC station(s) will be selected based on storm water volumes available.

8.2 Laboratory Quality Assurance/Quality Control

Analytical quality assurance for this program includes the following:

- Employing analytical chemists trained in the procedures to be followed.
- Adherence to documented procedures, EPA methods and written Standard Operating Procedures (SOPs).
- Calibration of analytical instruments.
- Use of quality control samples, internal standards, surrogates and Standard Reference Materials (SRMs).
- Complete documentation of sample tracking and analysis.

Internal laboratory quality control checks will include the use of internal standards, method blanks, matrix spike/spike duplicates, duplicates, laboratory control spikes and SRMs. These QA/QC activities are discussed below, and their applicability to each analysis is summarized in Table 8-2. Data quality objectives are summarized in Table 4-2.

8.2.1 Laboratory Replicates

On a frequency of once every ten samples collected at a given site or once per sampling station, whichever is more frequent, one sample for each analytical method should be split by the laboratory into two portions and each analyzed. Once duplicate analyses have been analyzed, the results are evaluated by calculating the relative percent difference (RPD) between the two sets of results. This serves as a measure of the reproducibility, or precision, of the sample analysis. Typically, duplicate results should fall within an accepted RPD range, depending upon the analysis.

8.2.2 Method Blanks

On a frequency of one per batch of 20 or fewer samples, a method blank sample is performed for each analytical method. A method blank is an analysis of a known clean matrix that has been subjected to the same complete analytical procedure as the sample to determine if potential contamination has been introduced during processing. Blank analysis results are evaluated by checking against reporting limits for that analyte. Results obtained should be less than the reporting limits for each analysis.

Table 8-2. Quality Control Procedures by Analyte

Analyte	Equipment/ Container Blanks	Method Blanks	Field and Lab Duplicates	MS/MSDs[a]	LCS[b] or SRMs[c]
Hardness as $CaCO_3$	—	✓	✓	—	✓
Total Dissolved Solids (TDS)	—	✓	✓	—	✓
Total Suspended Solids (TSS)	—	✓	✓	—	✓
Conductivity	—	✓	✓	—	✓
Temperature	—	—	✓	—	✓
pH	—	—	✓	—	✓
Total Organic Carbon (TOC)	✓	✓	✓	✓	✓
Dissolved Organic Carbon (DOC)	✓	✓	✓	✓	✓
Ammonia (NH_3-N)	—	✓	✓	—	✓
Nitrate as Nitrogen (NO_3-N)	✓	✓	✓	✓	✓
Total Kjeldahl Nitrogen (TKN)	—	✓	✓	—	✓
Total Phosphorus	—	✓	✓	—	✓
Dissolved Ortho-Phosphate	—	✓	✓	—	✓
Total Metals	✓	✓	✓	✓	✓
Dissolved Metals	—	—	✓	✓	✓

[a] Matrix Spike and Matrix Spike Duplicates
[b] Laboratory Control Samples
[c] Standard Reference Materials

8.2.3 Spikes

Two different kinds of spikes are to be used: matrix spikes and laboratory control (blank) spikes. Matrix spikes involve adding a known amount of the chemical(s) of interest to one of the actual samples being analyzed. One sample is split into three separate portions. One portion is analyzed to determine the concentration of the analyte in question in an un-spiked state. The other two portions are spiked with a known concentration of the analytes of interest. The recovery of the spike, after accounting for the concentration of the analyte in the original sample, is a measure of the accuracy of the analysis. By determining spike duplicate recoveries, another measure of precision is accomplished. An additional precision measure is made by calculating the RPD of the duplicate spike recoveries. Both the RPD values and spike recoveries are compared against accepted and known, method dependent, limits. Analyses outside these limits are subject to corrective action.

The second spiking type is a laboratory control spike. This procedure involves spiking known amounts of the analyte of interest into a known clean matrix to assess the possible matrix effects on spike recoveries. High or low recoveries of the analytes in the matrix spikes may be caused by interferences in the sample. Laboratory control samples assess these possible matrix effects since the matrix is known to be free from interferences. Matrix and laboratory control spikes are analyzed at a frequency of once every ten samples collected at a given site or once per sampling station, whichever is more frequent.

8.2.4 Standard Reference Materials (SRMs)

On a frequency of one sample per batch of 20 or fewer samples, an SRM should be analyzed if available. SRMs may be used in lieu of LCSs. An SRM is a sample containing a known and certified amount of the analyte of interest and is typically analyzed by personnel without the knowledge of that concentration. SRMs are typically purchased from independent suppliers who prepare them and certify the analyte concentrations. Results are evaluated by comparing results obtained against the known quantity and the acceptable range of results supplied by the manufacturer.

8.3 Corrective Action

Corrective action is taken when an analysis is deemed out of control for some reason. This includes exceedances of the RPD ranges, spike recoveries, and blanks. The corrective action varies somewhat from analysis to analysis, but typically involves the following: a check of procedure, documents and calculations to identify any possible error; correction of errors, like calculations, to improve results; a re-analysis of the sample extract, if available, to see if results can be improved; and finally, complete reprocessing and re-analysis of additional samples material, if available.

9 DATA MANAGEMENT AND REPORTING PROCEDURES

9.1 Data Management

Stephanie Panza will be responsible for laboratory data management and Tully McCarthy will be responsible for hydraulic and hydrologic data management (Figure 1-1). Overall management of the data will be consistent with established Caltrans and URS' procedures for storm water monitoring projects.

The Sample Control section will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control receives the original hard copy from the laboratory, verifies completeness and logs the date of receipt. A copy of the data set is filed in Sample Control's central filing system and another copy is provided to the Database Manager. The originals are then transferred to the Task Order Manager and filed with all other original project documentation in order to maintain complete project records.

The Laboratory will be requested to provide data in both hard copy and electronic formats. The form of electronic submittals will be provided to the laboratories to ensure that the files can be processed using the Caltrans Automated Data Validation software. A relational database will be used for all data. Laboratory data will be maintained and managed with Microsoft Excel and/or Microsoft Access. Files from the storm water monitoring stations will also be stored in the same database system and linked to the laboratory database. The data logger files will include rainfall, sampling, and discharge data. Site characteristics will be stored in a separate file and linked to both the chemical and data logger files to enable useful data queries.

9.2 Reporting Procedures

Several types of reports will be submitted in association with this Task Order. Monthly status reports will be submitted, which will summarize activities and accomplishments for the previous month. They will be submitted to the Project Coordinator on or prior to the fifth of each month. Status reports will provide information on work completed to date, as well as estimates of work yet to be completed. A post-storm technical memo will be submitted 3 weeks following a sampled event. The memo will include a brief description of storm, sample status, storm flow data, and a summary of analytical results. A technical report providing a summary and evaluation of the data set from each site is not currently part of the URS scope of work. However, if requested by Caltrans through task order amendment or new task order, a report will be prepared that summarize the collected data for the storm season and present statistical analysis results.

10 REFERENCES

California Department of Transportation [Caltrans]. 2000. *Caltrans Guidance Manual: Storm Water Monitoring Protocols*. California Department of Transportation, Environmental Program MS-27. July 2000.

United States Environmental Protection agency [USEPA]. 1999. *Methods and Guidance for Analysis of Water on CD. USEPA Office of Water*. EPA 821-C-99-004. June 1999.

USEPA. 1996. *Method 1669. Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels.* USEPA, Office of Water. July 1996.

United States Geological Survey [USGS]. 1998. *National Field Manual for the Collection of Water-Quality Data. Techniques of Water-Resources Investigations. Book 9. Handbooks for Water-Resources Investigations*. USGS, Office of Water Quality. September 1998.

Appendix A

APPENDIX A
CLEAN SAMPLING TECHNIQUES

CLEAN SAMPLING TECHNIQUES

The following topics are discussed below:

- Clean Sample and Equipment Handling
- Composite Bottle Changing
- Bottle and Equipment Cleaning

CLEAN SAMPLE AND EQUIPMENT HANDLING

During sampling operations, extreme care must be taken to minimize exposure of the sample and sample collection equipment to human, atmospheric, and other sources of contamination. This section provides clean sample and equipment handling procedures to be used when samples are collected for-level analysis.

Clean sampling techniques typically require a two person sampling team. Upon arrival at the sampling site, one member of the sampling team is designated as "dirty hands"; the second member is designated as "clean hands". Operations involving contact with the sample bottle, sample bottle lid, sample suction tubing, and the transfer of the sample from the sample collection device (if the sample is not directly collected in the bottle) to the sample bottle are handled by "clean hands" wearing clean powder-free nitrile gloves. "Dirty hands" (also wearing clean powder-free nitrile gloves) is responsible for preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve handling items that have direct contact with the sample. "Clean hands" will change into clean gloves as frequently as required to ensure that the gloved hands contacting the sample container, container lid, and laboratory cleaned sampling equipment have not contacted any source of potential contamination.

Although the duties of "clean hands" and "dirty hands" would appear to be a logical separation of responsibilities, in fact, the completion of the entire protocol may require a good deal of coordination and practice. For example, "dirty hands" must open the box or ice chest containing the sample bottle and unzip the outer bag; "clean hands" must reach into the outer bag, open the inner bag, remove the bottle, collect the sample, replace the bottle lid, put the bottle back into the inner bag, and zip the inner bag. "Dirty hands" must close the outer bag and place the double-bagged sample in an ice-filled ice chest. It is recommended that a third sampling team member be available to direct the team, review the monitoring plan, and complete the necessary sample documentation (e.g. sample location, time, sample number, weather conditions, etc.). If a third sampling team member is not available, "dirty hands" must perform the sample documentation activities.

COMPOSITE BOTTLE CHANGING

If a composite bottle change is required, composite bottle changing is conducted using the following steps:

1. The automated sampling equipment is placed in pause mode prior to the initiation of a composite bottle change. This action is accomplished in the field or by remote monitoring personnel if the monitoring station is equipped with telemetry.

2. Composite bottle changing requires two field team members- "clean hands" and "dirty hands". Both team members wear clean, powder-free nitrile gloves. "Clean hands" only touches suction tubing and Teflon composite bottle lids. Keep extra gloves within easy reach.

3. Prior to putting on clean gloves, the clean empty sample bottle is placed near the automated sampling unit, and the sampler is opened.

4. Wearing clean powder-free nitrile gloves, "dirty hands" removes the lid clamps from both the full sample bottle and the clean sample bottle.

5. "Clean hands" removes the end of the pump tubing from the composite bottle and "dirty hands" places a clean ziplock bag over the end of the tubing securing it with a rubber band. The inside of the bag should never be touched by sampling personnel.

6. "Clean hands" switches the bottle lids, putting the solid lid on the full bottle and the perforated lid on the clean empty bottle.

7. "Dirty hands" installs the lid clamps on both bottles, removes the full bottle from the sampler, replacing it with the clean empty bottle.

8. "Clean hands" holds the tubing while "dirty hands" removes the ziplock bag from the end of the pump tubing, being careful not to touch the tubing.

9. "Clean hands" inserts the tubing through the lid of the clean bottle.

10. The sampler is closed and sampling equipment is placed in sample mode. Remote operation personnel are notified as soon as the bottle change is complete.

11. The sampling team fills out the appropriate information on the label of the full sample bottle.

12. The full bottle is surrounded with fresh ice or frozen refreezable ice packets, and secured inside the vehicle for transport.

BOTTLE AND EQUIPMENT CLEANING

Using the procedures in the *Caltrans Guidance Manual* (Caltrans, July 2000), sampling equipment will go through a rigorous decontamination procedure prior to its use. The following procedures will be used:

COMPOSITE BOTTLES

1. Rinse bottle with warm tap water three times as soon as possible after emptying sample.
2. Soak the bottle in a 2 percent solution of detergent (e.g., Contrad®) for 48 hours; use a clean plastic brush to scrub the sides of the container.
3. Rinse three times with tap water.
4. Rinse five times with Milli-Q® or equivalent water (passed through two filters after deionized system), rotating the bottle to ensure contact with the entire inside surface.
5. Rinse three times with hexane, rotating the bottle to ensure contact with the entire inside surface (use 20 ml per rinse).
6. Rinse six times with Milli-Q® water.
7. Rinse three times with 2N nitric acid (1 liter per bottle, per rinse) rotating the bottle to ensure contact with the entire inside surface.
8. Rinse six times with Milli-Q® water.
9. Cap the bottle with Teflon® stopper cleaned as specified below.

TEFLON HOSES, LIDS, PERISTALTIC PUMP TUBING, AND STRAINERS

1. Make up a 2 percent solution of disinfectant soap (Micro®) in warm tap water.
2. Rinse tubing three times with the 2 percent Micro® Solution, wash lids and strainers with Micro® Solution and plastic brush.
3. Rinse three times with tap water.
4. Rinse three times with Milli-Q® water.
5. Rinse three times with a 2N nitric acid solution.
6. Soak 24 hours in a 2N nitric acid solution.
7. Rinse three times with Milli-Q® water.
8. Seal the tubing on both ends with clean latex material.
9. Individually double-bag tubing in new polyethylene bags properly labeled. Double-bag lids and strainers individually in zip-lock bags.

Appendix B

APPENDIX B
HEALTH AND SAFETY PLAN

TABLE OF CONTENTS

1.0 REVIEW HEALTH AND SAFETY PLAN

This Health and Safety Plan (HSP) is intended to address the special health and safety concerns that relate to the field work associated with the CHD Biofilter Strip Evaluation Program. URS Field Team members and its subcontractors field teams must be familiar with the contents of this document.

Field personnel working on the CHD Biofilter Strip Evaluation Program must become familiar with the HSP and site-specific safety concerns. The project Health and Safety Officer will be responsible for assuring that all members of the field team are familiar with the requirements of the HSP and have received appropriate training for their specific roles. General Caltrans safety guidelines can be found in Chapter 8: Protection of Workers (Division of Maintenance, revised June, 1993). The Project Health and Safety Officer will be responsible for enforcing Site-specific Health and Safety protocols. Site-specific Health and Safety protocols include Emergency Response/Contingency Plans. The project Health and Safety Officer and individual employees have authority to suspend work, if necessary, due to health and safety concerns.

1.1 Field Activities

Field activities associated with the CHD Biofilter Strip Evaluation Program are similar to other BMP evaluation programs. Activities will include:

Equipment Installation and Maintenance
Installation and maintenance may include working with power tools in wet or damp environments and the operation of heavy equipment. Confined space entry is not anticipated for this project.

Travel
Travel to and from the monitoring sites will occur for both routine maintenance activities and storm event monitoring. Although travel during the storm events will be minimized by use of automated equipment, some access is typically necessary during storm events and often at night to document observations, replace composite sample containers, and repair any equipment malfunctions.

Establishment of Work Zones and Traffic Control
Efforts were be made to locate equipment in safe work zones, far from high-traffic, high-use areas.

Removal and Replacement of Sample Containers
Composite sample containers will need to be removed and replaced immediately after each storm event and, perhaps, during storm events.

1.2 Traffic Safety

Working near roadways has several inherent risks that are dominated by the possibility of errant vehicles. The motoring public is largely made up of conscientious drivers operating well maintained equipment. However, some percentage of vehicles on the road at any given time may be marginally under control due to driver factors like distractions, fatigue, confusion, or inadequate training, as well as mechanical factors like vehicle age and condition. Unfortunately, the leading cause of serious driver impairment is Driving Under the Influence (DUI). Between 1990 and 1992, motorists who were DUI struck 10 of 11 highway workers killed on the job. Any or all of these factors may contribute to a vehicle leaving the traveled lanes and entering the work site.

Traffic load, posted speed limits, and proximity to travel lanes all have a direct relation to the probability of worker exposure to errant vehicles. Work site selection can reduce the exposure potential relating to these factors. Caltrans and the previous consultant considered these factors when evaluating the merits of candidate sampling sites. In all cases, the Field Team Leader will make the final evaluation of the appropriateness of performing work with the conditions present at a site.

Field Teams will utilize signs, cones, and flashing amber lights when necessary to inform motorists of activities that may impact roadway travel conditions. To avoid shoulder closures, attempts will be made to pull vehicles off the road and perform work as far away from the edge of pavement as possible. Vehicle pullouts were provided at many of the work locations. Should a shoulder closure become necessary, URS will comply with Caltrans Traffic Control Standard Plan T-10 and any other site-specific applicable Caltrans requirements and standard provisions listed in the encroachment permit for the District of operation. District requirements usually include special notification requirements and specific hours of operation.

Field members will work in teams and utilize high visibility vests or clothing and hard hats when working along roadsides.

Exiting and entering the highway to/from the shoulder when approaching and leaving sampling sites will be performed in a manner consistent with the roadway conditions present. The use of flashing amber lights as well as turn signals will be required. Drivers will evaluate run-off/run-on distances with respect to traffic load and traffic speed before attempting to exit to the shoulder. The Field Team Leader will consider the possibility of significant changes in road conditions taking place within the duration of planned work at the sampling site.

When working on or near the shoulder, physical barriers should be employed whenever possible to protect workers from errant vehicles. Physical barriers include barrier vehicles, guardrails, fences, and other man-made or natural objects capable of slowing, stopping, or diverting an errant vehicle. Barrier vehicles are to be unoccupied, positioned upstream of the work zone, and parked so as to not roll into the work area or active travel lanes if struck by an errant vehicle. Workers not protected by a physical barrier should employ the use of a lookout whose sole responsibility is to watch traffic for signs of potential trouble and notify endangered workers to make use of a pre-planned escape route. The lookout must have an effective means of communicating with workers in the noise and visual condition present.

1.3 Hazardous Material Spills

Operations, maintenance, and monitoring activities at field sites can potentially bring personnel in contact with a hazardous material spill. If a hazardous material spill occurs, do the following:

1. First notify Caltrans and the CHP as your primary and initial contact. Then, notify Public Safety or the local fire department immediately. Report the location of the spill, the source if known, and the nature of the material. Hazardous spills will also be reported to the Department of Transportation's National Response Center (NRC) at 800-424-8802.

2. Evacuate to a safe area. No employee shall knowingly approach a spill or leak of hazardous materials except under the specific direction of the person in charge.

3. Do not attempt to clean up a spill or leak of a known or suspected hazardous material.

4. Attempt to contain the spill or leak only if the material is known, proper safety equipment is worn, and the person in charge has deemed it safe to do so.

1.4 General Safety

In addition to traffic hazards, field teams may face a variety of potential dangers while maintaining the facilities, installing equipment and performing environmental monitoring. Some these dangers include:

- Slippery conditions
- Lightning
- Fast moving water
- Unstable earth
- Poor visibility, especially at night
- Lifting heavy objects
- Transients
- Muggers and other criminals
- Power tools and heavy equipment

- High places
- Sharp edges – broken glass
- Overhead dangers
- Dogs and other biological hazards
- Electrical hazards posed by equipment malfunctions

Always be aware of these dangers and all other hazards. Here are some tips that will help increase your safety and the safety of others while working in the field:

- Stay away from the edges of a fast moving body of water. These edges are usually slippery and unstable during rainy conditions.
- If sampling is required at the edge of a fast moving body of water, use a lifeline and a personal flotation device. Have on hand a grabbing device when possible.
- Never work alone at night, and avoid working alone during the day. Two people are required during each site visit.
- Avoid leaving materials, tools and equipment lying around where someone can trip over them.
- Maximize lighting at all times, especially at night.
- Keep a phone or other means of communication nearby.
- Do not use your back to lift heavy objects. Get help.
- Never use drugs or alcohol while working.
- Always wear a hard hat, orange reflective vest, and appropriate shoes.
- Do not use power tools and heavy equipment unless trained in the proper use and care of the specific power tools.
- Always wear eye protection when working with tools or chemicals.
- Always carry a charged cellular phone.
- Wear rain gear.

- Never leave open holes unattended or not barricaded.
- Do not sample during lightning.
- Clean up the work area before leaving.

2.0 SITE-SPECIFIC HEALTH AND SAFETY PLAN

This section provides information on unique hazards and necessary precautions for the types of sites that will be monitored during this study. Appropriate emergency response numbers and routes to the nearest medical emergency facilities can be found at the end of this appendix. Field personnel will be responsible for adhering to the requirements of this plan for installation, maintenance, and storm monitoring. If additional measures are necessary due to unforeseen or temporary changes to the work environment, the on-site team leader will make the final judgment for any safety procedure changes.

2.1 Site Specific Safety Concerns

2.1.1 Errant Vehicles

There is a moderate exposure hazard from errant vehicles while accessing most sites. While personnel are stopped on the shoulder of the highway, they should keep well back from the highway lanes and face the approaching traffic. A lookout person is required if two or more workers are engaged in exposed activity within 30 feet of the travel lane. Exposed activities will occur during pre-storm and post-storm operations. See Section 2 of the Sampling and Analysis Plan for site descriptions and access requirements for the individual facilities.

2.1.2 Chemical Hazards

Chemical hazards may collect within pipes and/or collection channels. Chemicals can be corrosive and will burn exposed flesh, and/or they can cause severe illness if they are absorbed through the skin or ingested. Exercise caution when dealing with a suspected liquid hazard. Use a pH meter or pH test paper to test for corrosivity, but always assume that a hazardous chemical is present and wear personal protective clothing. Chemical hazards other than those discussed above could be hazardous chemicals that have precipitated or accumulated on the sides of the pipes and channels. Table 2.1 lists potential chemicals that may be on site along with each chemical's Permissible Exposure Limit (PEL), Immediately Dangerous to Life and Health (IDHL), odor thresholds, and routes of entry. Personnel will use proper personal protective equipment to guard against chemical hazards.

Table 2.1. Toxic Gasses

Name	Source/Use	IDLH[a] Ceiling PPM	STEL[b] PPM/Exposure Time	TWA[c] 8 Hr PEL[d] PPM	Odor Threshold
Ammonia	Sewer Gas	300	35/15	25	low
Acetone	Solvent	2,500	1,000/15	750	100
Benzene	Industrial Solvent	500	5/15	1	4.6
Carbon Dioxide	Comb./Sludge	40,000	30,000/15	5,000	-
Carbon Monoxide	Comb. Exhaust	1200	-	25	-
Carbontetrachloride	Industrial Solvent	200	-	2	21.4-200
Chlorine		10	1/15	0.5	
Gasoline	Fuel	-	500/15	300	0.005-10
Hydrogen Sulfide	Sewer/Sludge Coal Gas/Petrol.	100	15/15	10	Impairs smell
Isopropyl Alcohol	Solvent	2,000	500/15	400	50
Nitrogen Oxides		20	1/15	-	-
Ozone	Electric Arcing	5	0.3/15	0.1	0.015
Sulfur Dioxide	Industrial Waste	100	50/15	2	-
Toluene	Solvent	500	150/15	50	0.17-40
Xylene	Solvent	900	150/15	100	0.5-2,000

[a] IDLH (Immediately Dangerous to Life and Health)
[b] STEL (Short Term Exposure Limit)
[c] TWA (Time Weighted Average)
[d] PED (Permissible Exposure Limit)

2.1.3 Physical Hazards

Always be alert and use adequate protection to safeguard against the physical hazards associated with working at these sites. The most common hazard encountered is falling or tripping. The following are some other common hazards:

- Falling objects
- Sharp objects
- "Flash" flooding
- High water
- Electrical shock
- Grinding
- Chipping

- Moving vehicles and heavy equipment operation
- Mechanical energy
- Engulfment (collapse of a confined space)

2.1.4 Biological Hazards

Beware of poison ivy, poison oak, and other plants that cause allergic reactions. Also, use protection against bacteria and other microbiota that could be present in the water and sediment. Be aware that mosquitoes are a common vector for human diseases.

2.1.5 Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing. The same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. In its early stages, heat stress can cause rashes, cramps, discomfort, and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and coworkers. Continued heat stress can lead to heat stroke and death. Avoiding overprotection, careful training and frequent monitoring of personnel who wear protective clothing, judicious scheduling of work and rest periods, and frequent replacement of fluids can protect against this hazard.

2.1.6 Cold Exposure

Storms can bring unusual cold weather to an area. Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and wet conditions. To guard against this hazard, wear appropriate clothing, have warm shelter readily available, carefully schedule work and rest periods, and monitor workers' physical conditions.

2.2 Worker Safety

Only personnel trained in the use of the proper safety equipment will be allowed to complete the required tasks.

2.2.1 Personal Protective Equipment

Personal protective equipment recommended includes hard hats, safety vests, work boots, gloves, and sturdy clothing. This equipment will not only help protect against numerous potential hazards but will also allow others to identify you as belonging to the work site. Additionally, Nitrile, latex, or other plastic-based personal protective equipment will be used by any personnel who is likely to come in contact with storm water runoff as the contents of the water are unknown and potentially dangerous.

2.2.2 Special Circumstances

Extreme caution will be used when maintaining pole-mounted equipment. Qualified individuals will perform this task with proper equipment due to the danger of potential falls.

2.3 Traffic Safety

A rotating amber light is required when accessing many of the biostrip facilities. A shoulder closure will be considered for all work near the shoulder that is expected to last more than 30 minutes. Traffic control requirements described in the encroachment permit for the individual facilities shall be followed.

2.4 Sampling Safety

The following precautions will be taken while sampling at biostrip facilities:

- Use plenty of light during the evening hours and use reflective orange vests if working near the highway.
- Always wear protective gloves, an orange reflective vest and a hard hat.
- Wear boots and foul weather gear during rainy weather.
- Do not eat or smoke while sampling.
- Use proper lifting techniques and get assistance when moving coolers and large sample composite containers.

2.5 Emergency Procedures

2.5.1 Medical Emergencies

Even with full safety awareness and compliance by field teams, medical emergencies can and do occur. To handle minor injuries, field teams will have a basic first aid kit on-site at all times. At the end of this appendix is a list of site-specific emergency contacts, driving directions, and maps to the hospital nearest each site.

2.5.2 Other Emergencies

In the event of fire, flooding, structural collapse, or hazardous spills, immediately notify emergency services and evacuate the area. Accidents or unusual events that endanger workers must be documented and promptly reported to the Corporate Safety Director, Project Safety Officer, and proper authorities.

2.6 Hazardous Spills

Hazardous substances may be used for various purposes at and around the site. When working with hazardous substances, leaks and spills are always a concern. With the close proximity of the site to the roadway, the probability also exists of potential hazardous spills originating from traveling vehicles.

A spill may present a number of hazards. The specific hazards depend on the substance(s) involved. Among the possibilities are:

- Fire
- Explosion
- Contamination of individuals who come in contact with the spilled substance
- Hazardous substances entering the water supply

Spill response procedures are designed to minimize the risk of any of these things occurring as a result of a spill or, at the very least, reducing the degree of hazard. The primary concern of spill contamination is to stop or retard the spill before it becomes serious.

Field teams working with potentially hazardous materials will be trained in the use of proper personal protective equipment, the safe usage or handling of the substances, and contingency plans for spills and leaks. In the event of a hazardous material spill, follow the procedures listed in Section 1.3 of this Appendix. The hazards posed by a spill of a particular substance are detailed on the Material Safety Data Sheet (MSDS) for that substance. In the event of a hazardous material spill originating from an external source such as an accident on the roadway, follow the procedures listed in Section 1.3 of this Appendix.

2.7 Tailgate Safety Training

A designated Safety Officer will conduct tailgate safety training sessions regularly. These meetings will be held on-site prior to work operations. New personnel working on site will be required to attend a tailgate meeting prior to work operations. The purpose of the safety-training meeting is to ensure that field team members understand and will abide by all safety and potential emergency response measures that may be necessary for the well being of the field team.

The following items will be discussed at each safety meeting:

- Traffic safety.
- Safe entering and exiting of the freeway.
- Use of personal protective clothing and equipment.
- Potential chemical and physical hazards and how to deal with them.
- Nearest hospital information.
- Emergency response procedures.
- Any other site-specific safety issues.

Field team members must sign the tailgate safety training meeting form in acknowledgment of understanding all issues discussed. An example of a tailgate meeting form is included as Figure 2.1 of this Appendix.

Figure 2.1 Tailgate Safety Meeting Form

Date: ________________ Time: ________________ Project Number: ________
Site Name: ____
Site Location: ____

Safety Topics Presented

Traffic Safety and Control:

Protective Clothing/Equipment:

Chemical Hazards:
Physical Hazards:
Confined Space Entry Procedures:
Emergency Response Procedures:
Other Site-Specific Issues:

Nearest Hospital:
Phone #:
Ambulance Phone #:
Hospital Address and Route:

ATTENDEES

Name Printed Signature

Meeting conducted by: ___________________________ ___________________________
Name Printed Signature

Project Safety Officer: _________________________________
Project Manager: ___________________________________

Emergency Contacts for Site #1 (Sacramento), District 3

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	916-428-1324	Call for confined spaces
Non-Emergency Police Dispatch	916-277-6140	Non-emergency
Local Highway Patrol	916-657-7261	Call before beginning work
Kaiser Foundation Hospital	(916) 688-2000	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(916) 255-2802	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #2 (Cottonwood), District 2

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(530) 347-4737	Call for confined spaces
Non-Emergency Police Dispatch	(530) 245-6096	Non-emergency
Local Highway Patrol	(530) 347-1813	Call before beginning work
Redding Medical Center	(530) 244-5400	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(530) 225-3306	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #3 (Redding), District 2

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(530) 225-4141	Call for confined spaces
Non-Emergency Police Dispatch	(530) 225-4200	Non-emergency
Local Highway Patrol	(530) 225-2700	Call before beginning work
Redding Medical Center	(530) 244-5400	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(530) 225-3306	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #4 (San Rafael), District 4

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(415) 485-3300	Call for confined spaces
Non-Emergency Police Dispatch	(415) 485-3000	Non-emergency
Local Highway Patrol	(415) 557-1094	Call before beginning work
Marin General Hospital	(415) 925-7000	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(707) 762-5540	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #5 (Yorba Linda), District 12

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(714) 744-0400	Call for confined spaces
Non-Emergency Police Dispatch	(714) 993-8164	Non-emergency
Local Highway Patrol	(714) 567-6000	Call before beginning work
Kaiser Permanente Hospital	(714) 279-4200	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(949) 724-2787	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #6 (Irvine), District 12

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(949) 854-8209	Call for confined spaces
Non-Emergency Police Dispatch	(949) 724-7000	Non-emergency
Local Highway Patrol	(949) 567-6000	Call before beginning work
Irvine Regional Hospital	(949) 753-2000	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(949) 724-2152	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #7 (Moreno Valley), District 8

Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(909) 486-6784	Call for confined spaces
Non-Emergency Police Dispatch	(909) 955-2444	Non-emergency
Local Highway Patrol	(909) 383-4811	Call before beginning work
Riverside County Hospital	(909) 486-4000	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(909) 383-6922	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

Emergency Contacts for Site #8 (San Onofre), District 11

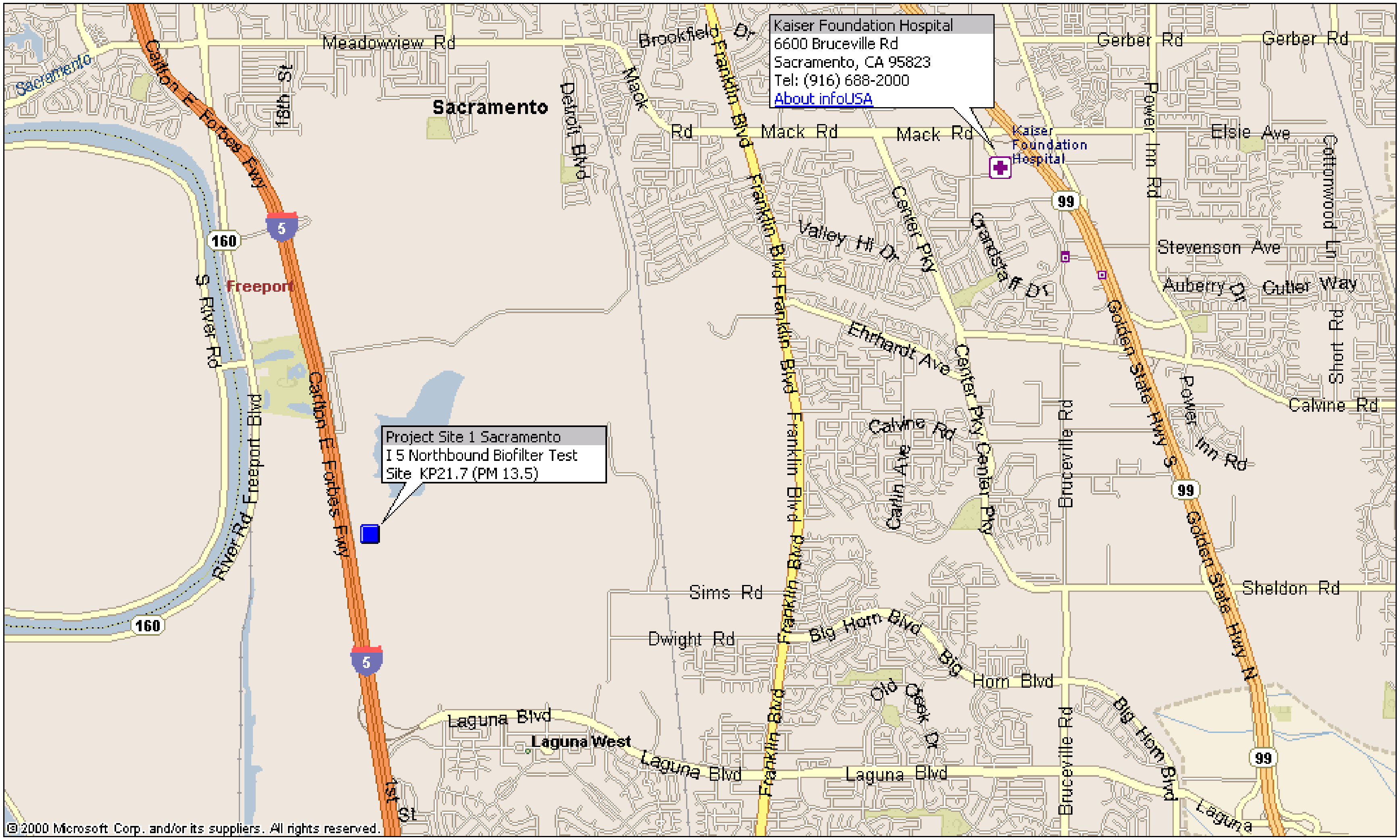
Name	Phone	Comments
California Highway Patrol	911	From cell phone
Police Department	911	From landline phone
Fire Department Emergency Dispatch	911	From landline phone
Fire Non-Emergency Dispatch	(949) 497-0700	Call for confined spaces
Non-Emergency Police Dispatch	(949) 361-8224	Non-emergency
Local Highway Patrol	(949) 487-4000	Call before beginning work
Columbia San Clemente Hospital	(949) 496-1122	Nearest hospital
Department of Transportation's National Response Center (NRC)	(800) 424-8802	Call in case of hazardous spills
Caltrans Field Inspector	(619) 944-7953	Notify for any accident or injury
URS Project Manager (Carol Forrest)	(619) 294-9400 (619) 888-7202	Notify for any accident or injury
URS Safety Officer (Nathan Jacobsen)	(619) 294-9400 (619) 888-5205	Notify for any accident or injury
URS Task Order Manager (Ed Othmer)	(619) 294-9400 (619) 888-0412	Notify for any accident or injury
Caltrans Program Manager (Misty Scharff)	(916) 278-8106	Notify for any accident or injury

Document all information related to the accident or incident that resulted in injury or damage and report it to Nathan Jacobsen at URS at (619) 294-9400

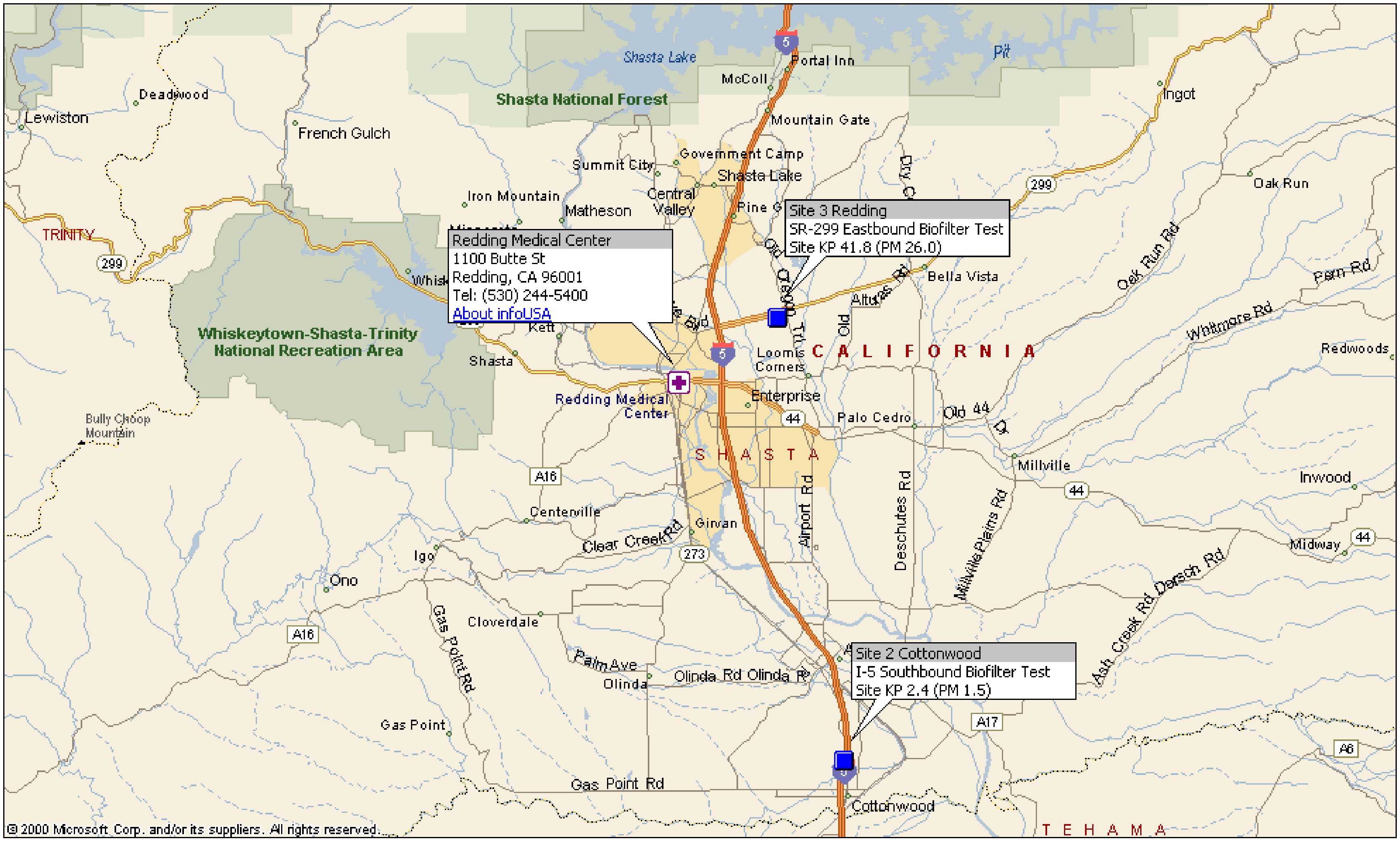
DRIVING DIRECTIONS TO HOSPITALS (SEE HOSPITAL MAPS FOR NEAREST HOSPITAL TO APPLICABLE SITE ON FOLLOWING PAGES)

Site No.	Site Location	Hospital Name/Address	Driving Directions from Site to Nearest Hospital
1	Sacramento	Kaiser Foundation Hospital 6600 Bruceville Rd Sacramento CA 95823 Telephone: 916 668-2000	I-5 north, exit Pocket/Meadow View; turn right; Meadowview becomes Mack Rd; turn right on Bruceville
2	Cottonwood	Redding Medical Center 1100 Butte St. Redding, CA 96001	I-5 south to Gas Point Road/4th Street; turn left at the bottom of the ramp; turn left onto I-5 north; take Cypress Avenue exit towards Redding; turn left onto E. Cypress Avenue; turn right onto SR-273 N.
3	Redding	Redding Medical Center 1100 Butte St. Redding, CA 96001	Exit onto Old Oregon Trail; tur left and take SR-299 west ramp; SR-299 becomes Lake Blvd.; turn left onto SR-273; turn left onto Placer St; turn left onto 273 N.
4	San Rafael	Marin General Hospital 250 Bon Air Road Greenbrae, CA 94904 Telephone: 415 925-7000	101 southbound to Sir Francis Drake exit towards Kentfield; keep right at the fork on the ramp; merge onto Sir Frances Drake Blvd; turn left onto Bon Air Road
5	Yorba Linda	Kaiser Permanente Hospital 441 N. Lakeview Ave. Anaheim, CA 92807 Telephone: 714 279-4200	SR-91 westbound; exit Lakeview; turn right on Lakeview: 449 North Lakeview
6	Irvine	Irvine Regional Hospital 16200 San Canyon Ave. Irvine ,CA. 92618 Telephone: 949 753-2000	I-405 north; exit Sand Canyon; right on Sand Canyon
7	Moreno Valley	Riverside County Hospital 26520 Cactus Avenue Moreno Valley, CA 92555 Telephone: 909 486-4000	I-60 eastbound; exit Nason Street; turn right onto Nason Street; turn right onto Cactus Avenue
8	San Onofre	Columbia San Clemente Hospital 654 Camino Del Los Mares San Clemente, CA 92673 Telephone: 949 496-1122	I-5 northbound; exit Camino De Estrella; turn right onto Camino Del Los Mares

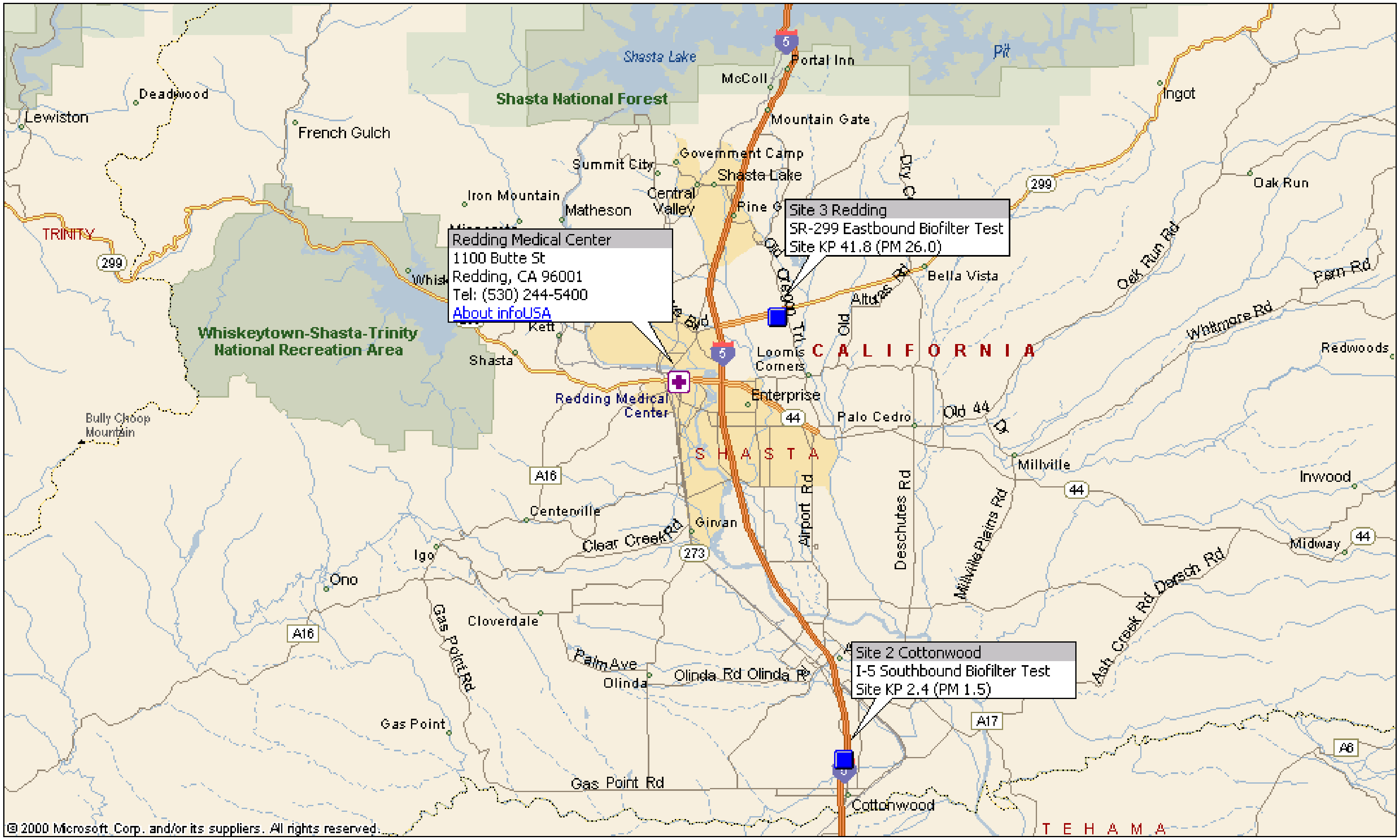
SITE #1 (SACRAMENTO) HOSPITAL MAP



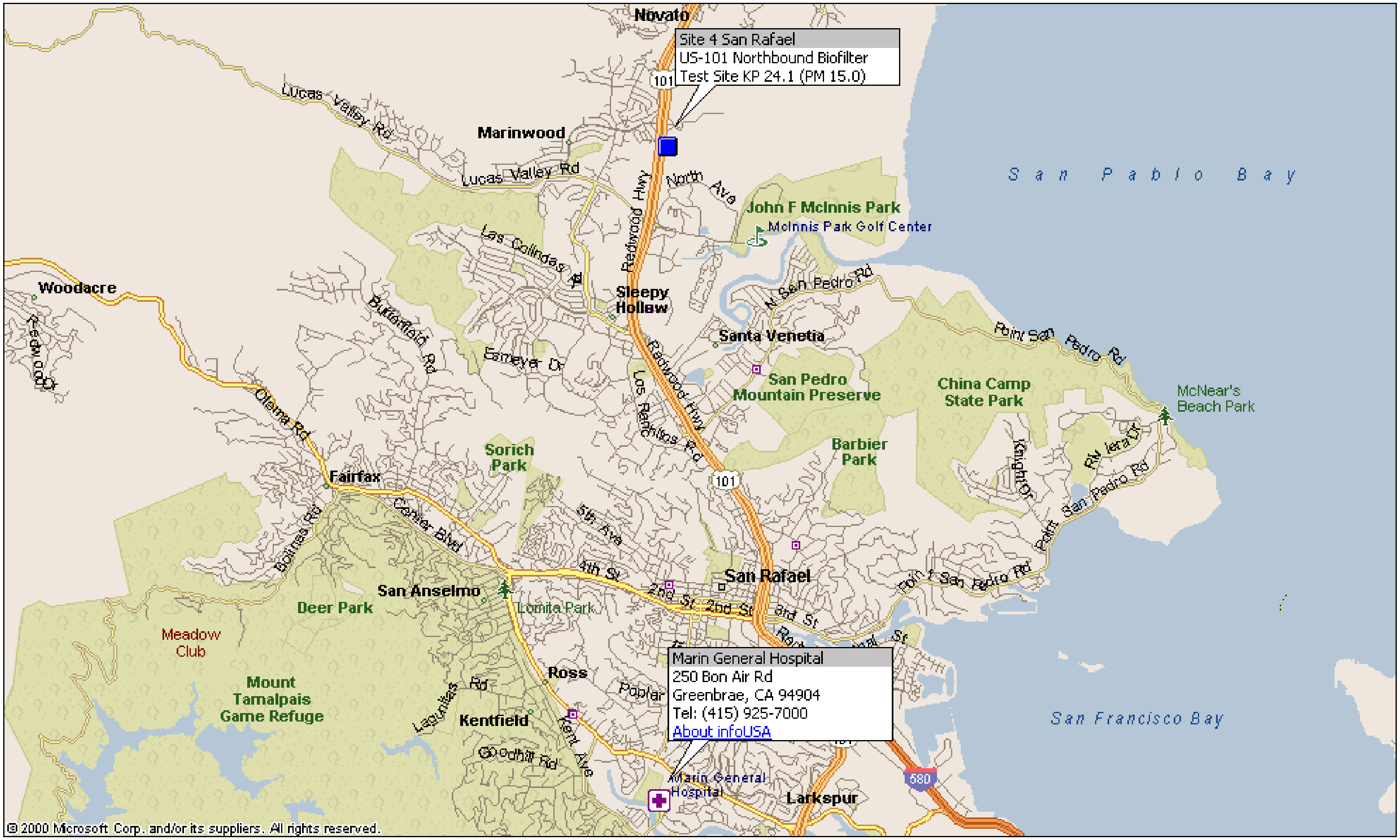
SITE #2 (COTTONWOOD) HOSPITAL MAP



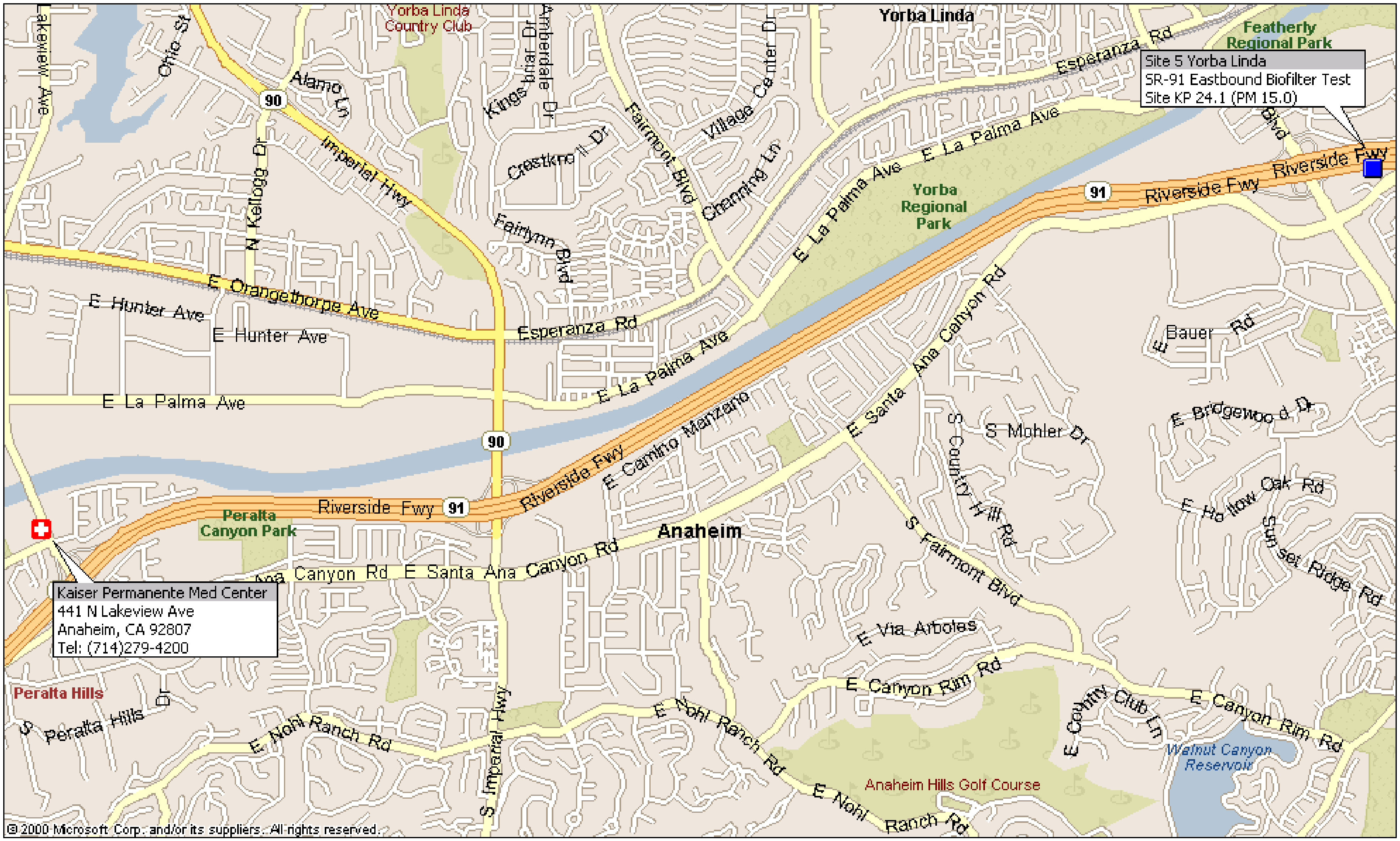
SITE #3 (REDDING) HOSPITAL MAP



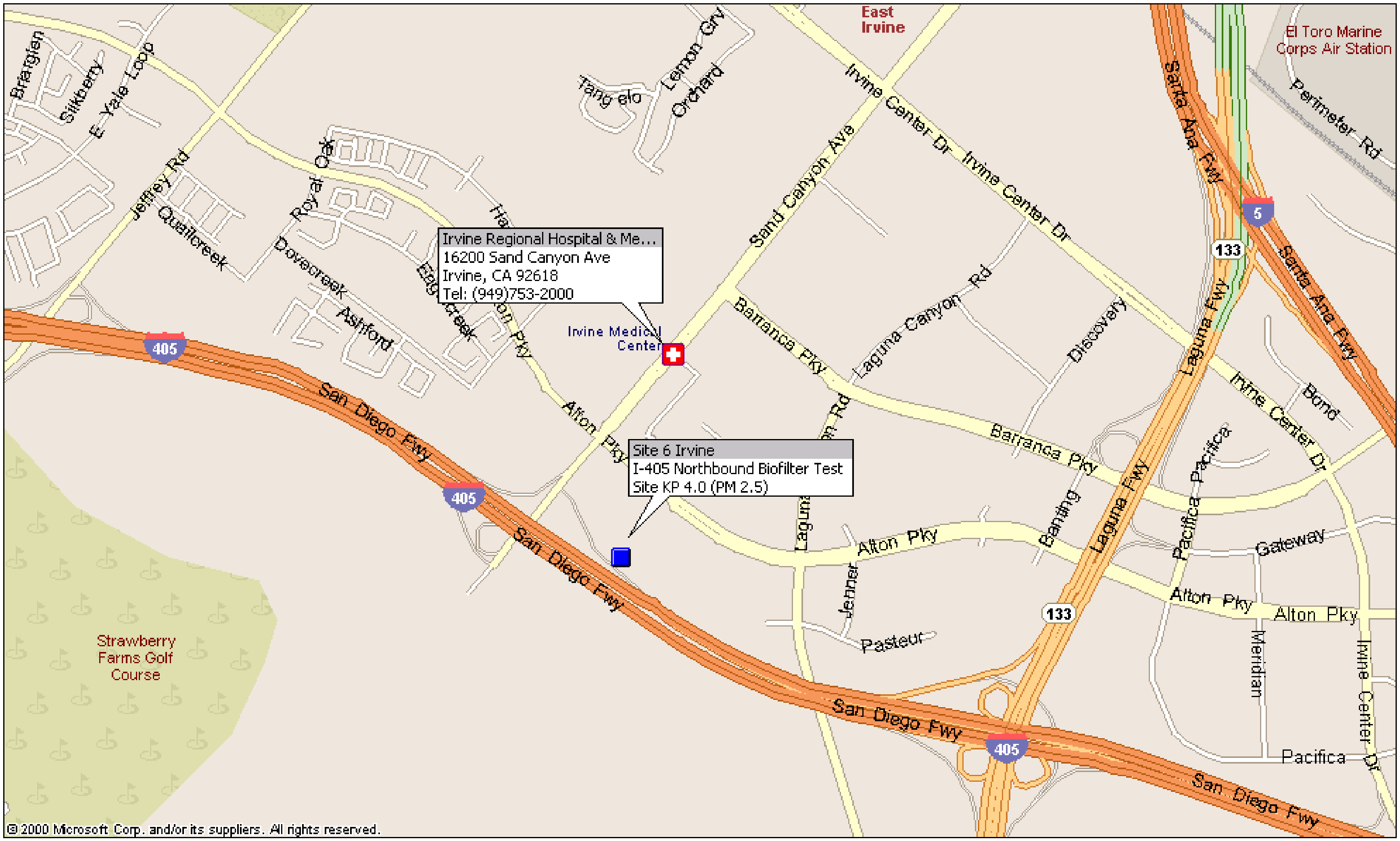
SITE #4 (SAN RAFAEL) HOSPITAL MAP



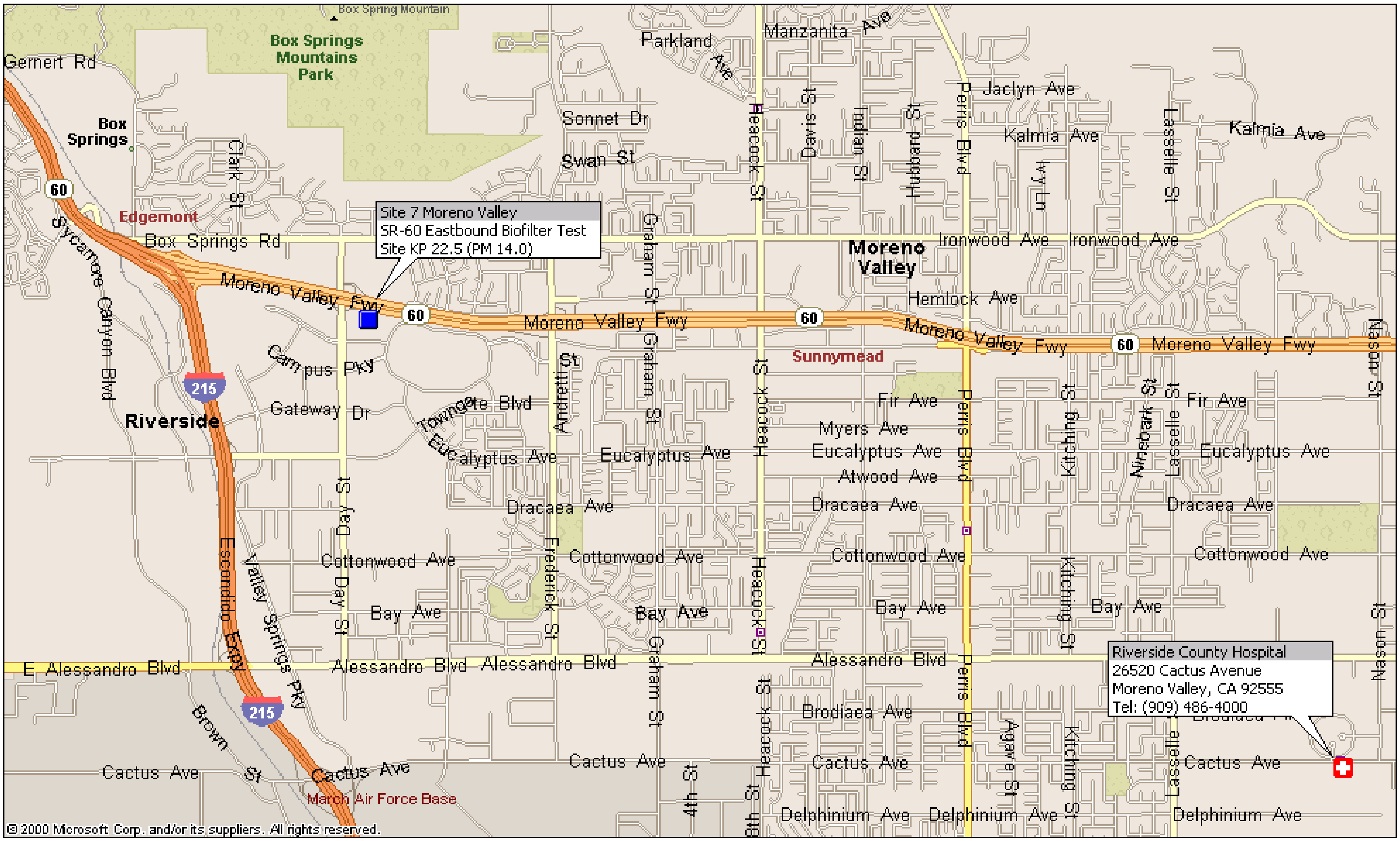
SITE #5 (YORBA LINDA) HOSPITAL MAP



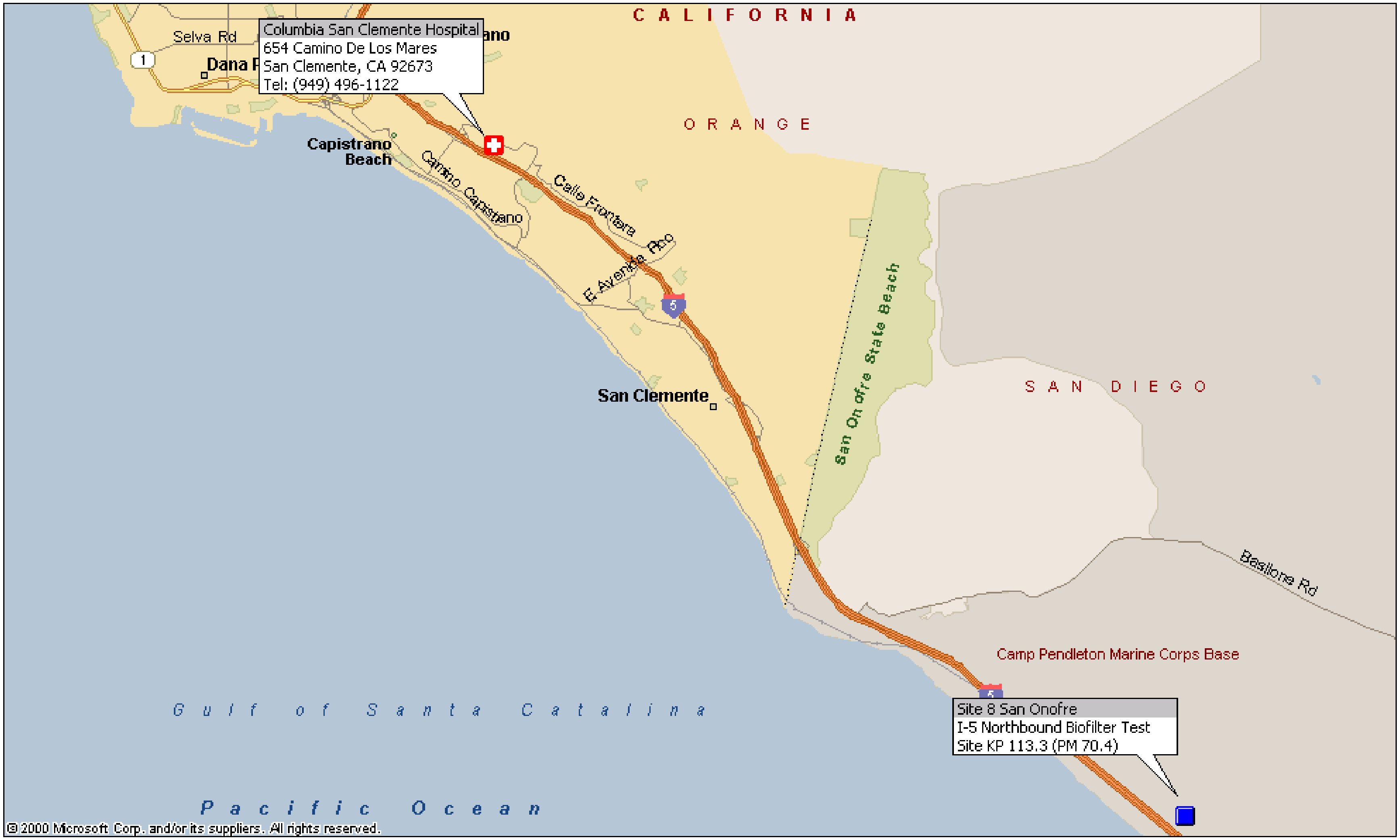
SITE #6 (IRVINE) HOSPITAL MAP



SITE #7 (MORENO VALLEY) HOSPITAL MAP



SITE #8 (SAN ONOFRE) HOSPITAL MAP



Appendix C

APPENDIX C
OBSERVATION AND MAINTENANCE LOG FORMS

Site:______________________System:_____________

Caltrans CHD Biofilter Strip Evaluation Program
Empirical Observations Field Data Log Sheet for Storm Events for Biofiltration Strips

GENERAL INFORMATION:

Date:	Time in:	Time out:
Team leader's initial:		Stormwater consultant:
Other personnel:		Temperature:

Purpose of visit (check all that apply): ☐ Storm monitoring ☐ Routine inspection
☐ Special inspection ☐ Maintenance

HYDROLOGIC AND HYDRAULIC CHARACTERISTICS:

Flow conditions (*check all that apply*): ☐ Runoff entering facility
☐ Flow distributed uniformly throughout Strip
☐ Flow not uniformly distributed throughout Strip

If flow is not uniformly distributed throughout the Strip, describe distribution (e.g., where concentrated, where channelized, approximate dimensions and depths of concentrations and/or channel):

Flow conditions continued (*check all that apply*):
☐ Water flowing through Strip at a perceptible velocity
☐ Facility discharging
☐ Flow bypassing facility
☐ Flow overtopping facility
Comments:

Standing water conditions (*record measurements as appropriate*):
☐ Water standing over entire Strip. Depth: __________
☐ Water standing in one isolated pool. Describe Location: ______________________________
Depth: __________
☐ Water standing in multiple pools: Describe Locations: ______________________________
____
Depths: ______________________________
Comments:

Photos Taken ☐ (During Post Storm visit)

Problems:

____
(Team Leader's Signature)

Site:______________________System:_____________

Caltrans CHD Biofilter Strip Evaluation Program
Site Inspection Field Data Log Sheet
for Biofiltration Strips (Quarterly)

Date:	Time in:	Time out:

VEGETATION CONDITION:

Strip bed vegetation cover:

☐ Complete ☐ Few small bare spots ☐ Few large bare spots ☐ Many small bare spots
☐ Many large bare spots ☐ Large areas bare ☐ All or nearly bare

Strip bed vegetation type:

☐ All grasses ☐ Mostly grasses, some wetland plants ☐ Mostly wetland plants, some grasses
☐ All wetland plants

Extent of woody shrubs or trees: ____

Strip vegetation height: ____________ inches
% Strip Vegetation dormant (brown) _______%

Vegetation condition comments:

SOLIDS DEPOSITION AND RESUSPENSION:

For the following locations, record the type (trash or debris, oil and grease, other organics), location(s), area(s) covered, and depth(s), as applicable:

In collection ditch: ____

____

Over entire Strip: ____

____

In one spot: ____

____

In multiple spots: ____

____

Solids resuspension evident (*check all that apply*):

☐ In inflow/influent channel ☐ Near inlet ☐ Near outlet ☐ In outflow/effluent channel
☐ Other (describe): ____

Solids deposition and resuspension comments:

Site:______________________System:_____________

Caltrans CHD Biofilter Strip Evaluation Program
Site Inspection Field Data Log Sheet
for Biofiltration Strips (Quarterly) (continued)

Date:	Time in:	Time out:

EROSION:

For the following locations, record erosion locations, area(s) covered, and depth(s), as applicable:

Fire break: ____

____

Near inlet: ____

____

Strip bed: ____

____

At strip/effluent channel interface : ____

____

Erosion comments:

STRUCTURAL CONDITION OF FACILITY:

Record the presence of the following (*check all that apply and give location in comments*):

☐ Collection ditch damage ☐ Vehicle damage ☐ Vandalism

Comments:

Site:_______________________System:_____________

Caltrans CHD Biofilter Strip Evaluation Program
Site Inspection Field Data Log Sheet
for Biofiltration Strips (Quarterly) (continued)

Date:	Time in:	Time out:

MONITORING EQUIPMENT CONDITION:

Inspection checklist (*check appropriate boxes*):

Flume(s) free of sediments and debris:
☐ Yes ☐ No ☐ Not applicable ☐ See comments below

Power supply functioning:
☐ Yes ☐ No ☐ Not applicable ☐ See comments below

Flow meter(s) functioning normally:
☐ Yes ☐ No ☐ Not applicable ☐ See comments below

Flow meter desiccant OK or replaced:
☐ OK ☐ Replaced ☐ Not applicable ☐ See comments below

Flow meter calibration:
☐ OK ☐ Recalibrated ☐ Not applicable ☐ See comments below

Samplers functioning normally:
☐ Yes ☐ No ☐ Not applicable ☐ See comments below

Sampler desiccant:
☐ OK ☐ Replaced ☐ Not applicable ☐ See comments below

Sampler suction line:
☐ OK ☐ Cleared ☐ Replaced ☐ Not applicable ☐ See comments below

Sampler intake:
☐ OK ☐ Cleared ☐ Replaced ☐ Not applicable ☐ See comments below

Sampler strainer:
☐ OK ☐ Cleared ☐ Replaced ☐ Not applicable ☐ See comments below

Peristaltic pump tubing:
☐ OK ☐ Cleared ☐ Replaced ☐ Not applicable ☐ See comments below

Comments:

____
(Team Leader's Signature)

Appendix D

APPENDIX D
SAMPLE COLLECTION AND PREPAREDNESS PROCEDURES

SAMPLE COLLECTION AND PREPAREDNESS PROCEDURES

STORM PROCEDURE

If upon arrival at a station during a storm event the status of the composite sample bottle is unknown, it should be checked immediately. If it is not necessary to change the bottle at that time, record all of the appropriate data on the log sheets. Determine an approximate time that the bottle will fill, and, depending on how much time is available, either get to the next station or wait until the bottle fills.

If the sample bottle is full, reset the system immediately and replace the bottle. Once the bottle has been successfully changed, fill in all of the necessary station data on the log sheets.

SAMPLE BOTTLE REPLACEMENT

The removal of the 20 L borosilicate sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. More importantly, if the sample is lost or contaminated, all of the effort and expense of the storm monitoring process is wasted. In all cases, two people should be present to ensure the security of the bottle and of the sample itself. Be extremely careful not to kink the intake hose when handling the sampler.

Always record the bottle number in the logbook and label the bottle appropriately. Once a new bottle has been put in place, re-ice and make sure the sampler is reset to continue sampling. Also, make sure that all full bottles are kept iced during transport to the laboratory.

STORM MONITORING (OFFICE)

The main objective of storm monitoring (office) is updating field teams on the status of their stations. This will greatly reduce the amount of time a field team must spend driving during storms. The monitoring of stations from a remote computer consists of either calling each station and recording certain data for evaluation or continually monitoring real-time updates on the main storm control computer. When it is determined that a bottle is close to filling, a field team must be called and alerted to the status of the station. All remote interrogation of the storm stations must be logged.

Generally, the Office Storm Monitor is also the Storm Control position. This means that all critical decisions regarding the status of the storm monitoring are made with input from the Office Monitor. Therefore, this position requires awareness of the latest weather forecasts in order to make informed decisions on the continued monitoring of the storm.

STATION SHUT DOWN

Once a storm event has ended, the stations need to be shut down. The stations should be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items must be taken care of, and, as always, everything should be well documented in the field log:

1. After all pertinent data has been recorded, reset the storm-monitoring program to prepare for another event.

2. Replace the 20 L sample bottle and reset the sampler.

3. Physically inspect the station to determine if any damage was sustained during the storm event. Determine if the flow sensor is blocked by debris, or the intake is clogged.

4. Download the data. This should be done via modem from the remote monitoring computer.

5. Check each of the battery voltages and replace those that are low.

6. Complete an Empirical Observation form.

EVALUATION

Upon termination of a monitoring event, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the biofilter strips?
- Was capture of peak flow or runoff achieved at all sampling points?
- Was the mass balance between the storm volumes of each collection system acceptable?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the biofilter strips function as designed?

SAMPLE HANDLING AND TRACKING

The importance of proper sample handling cannot be over-stressed. Water samples must be kept properly chilled and be transferred to the analytical laboratory within holding times to achieve representative data. To ensure proper tracking and handling of the samples, documentation must accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes Chain-of-Custody forms (Figure D-1).

DATA RETRIEVAL

The data stored in the memory of the data logger must be retrieved before the data are written over with new data or before power to the unit is interrupted. If the data are not retrieved prior to either of these events, they may be lost. The data logger memory stores data in a loop, and has enough memory space to record approximately 120 days of data before the earlier data are overwritten. Data should be retrieved (downloaded) from the data logger after each storm event during the storm season, and, during dry weather, approximately every month. The storm control computer does this automatically. However, verification that data has been successfully downloaded should be done on a regular basis.

Figure D-1. Chain of Custody Form

Laboratory:	Lab # Date Rec'd	**From:** URS 1615 Murray Canyon Road, Suite 1000 San Diego, CA 92108 (619) 294-9400 (619) 293-7920 Fax

URS Project: **P.O.#:**	**Project #:** **Required Completion Date:**

Sample ID #	Site ID #	Lab ID #	Matrix/Analysis	Containers	Pres.	Sample Date/Time		Condition Upon Receipt

Data Reports **MUST** include the following: Sample/Site ID, Analytical Method, Detection Limit, Date of Extraction if applicable, Date of Analysis, Analytical Results and Signature of QA Reviewer.

Special Instructions/Comments:

Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time